

October 1994/\$3

Mobile Radio Technology™

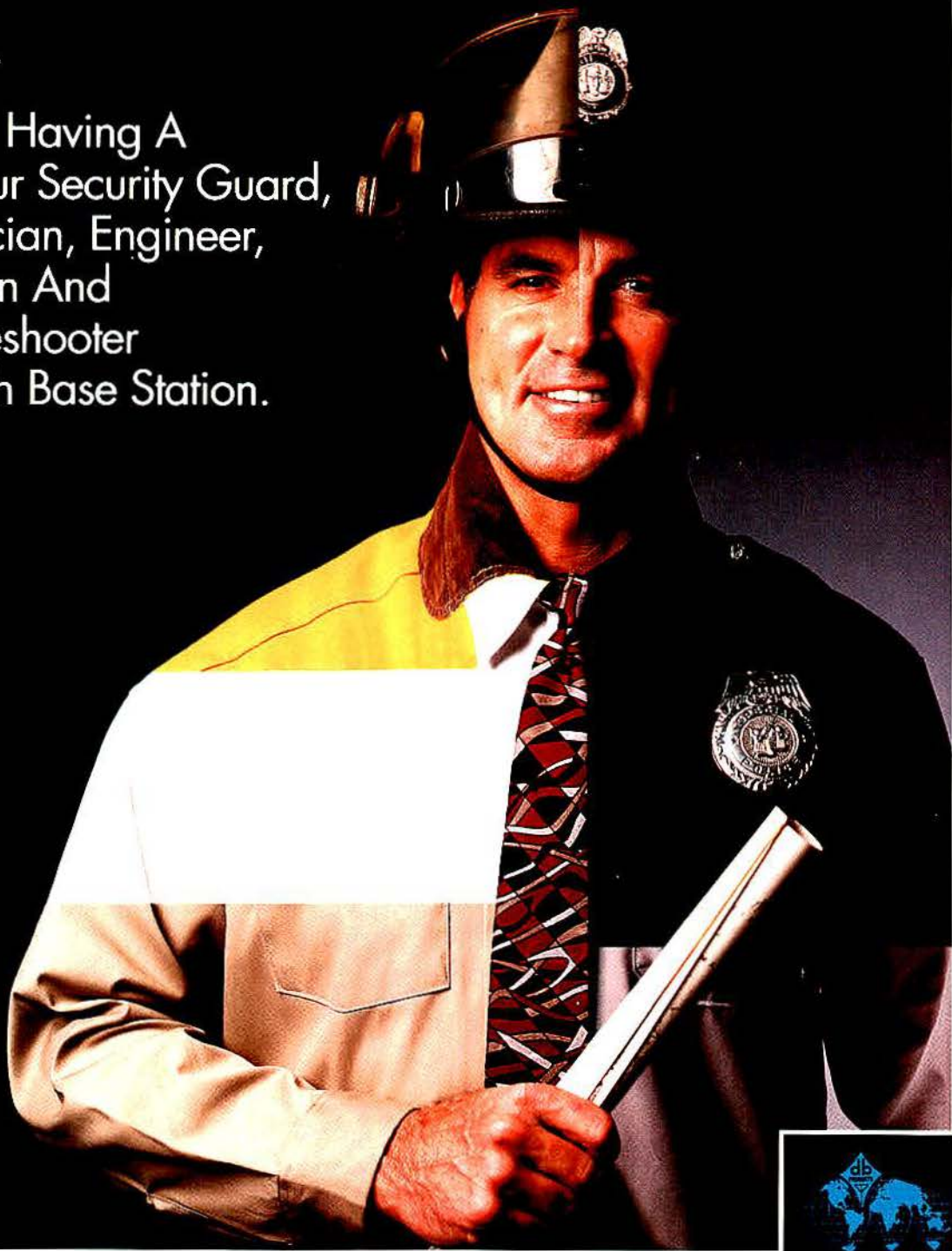
The journal of mobile communications technology



Combining, p. 10

- Servicing pagers
- Duplexers
- Trunking
- Mobile computing
- Telephone line-testing
- Mobile data

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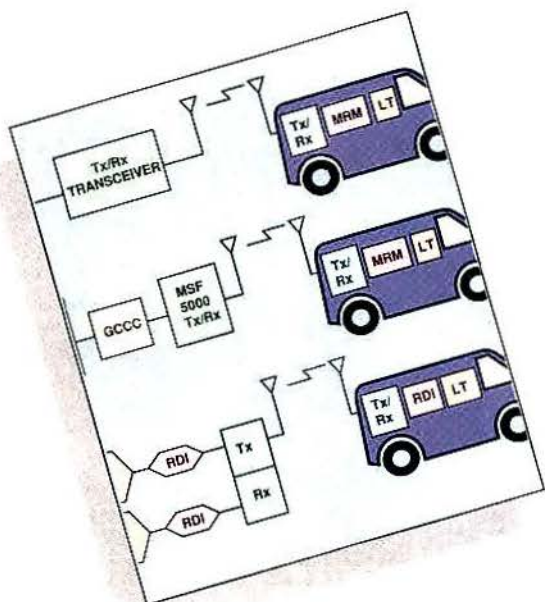
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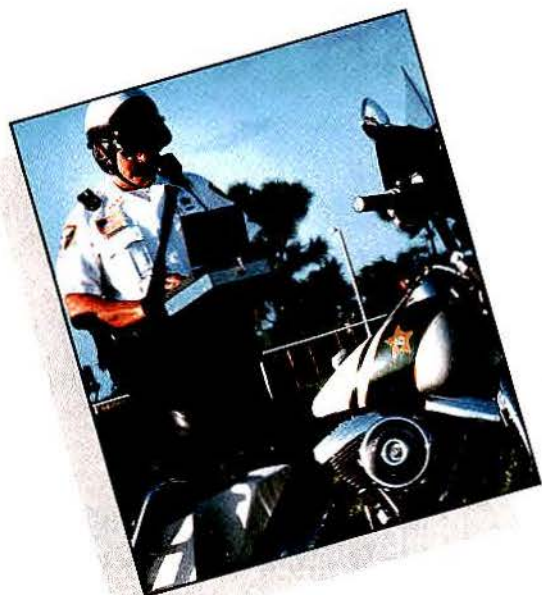
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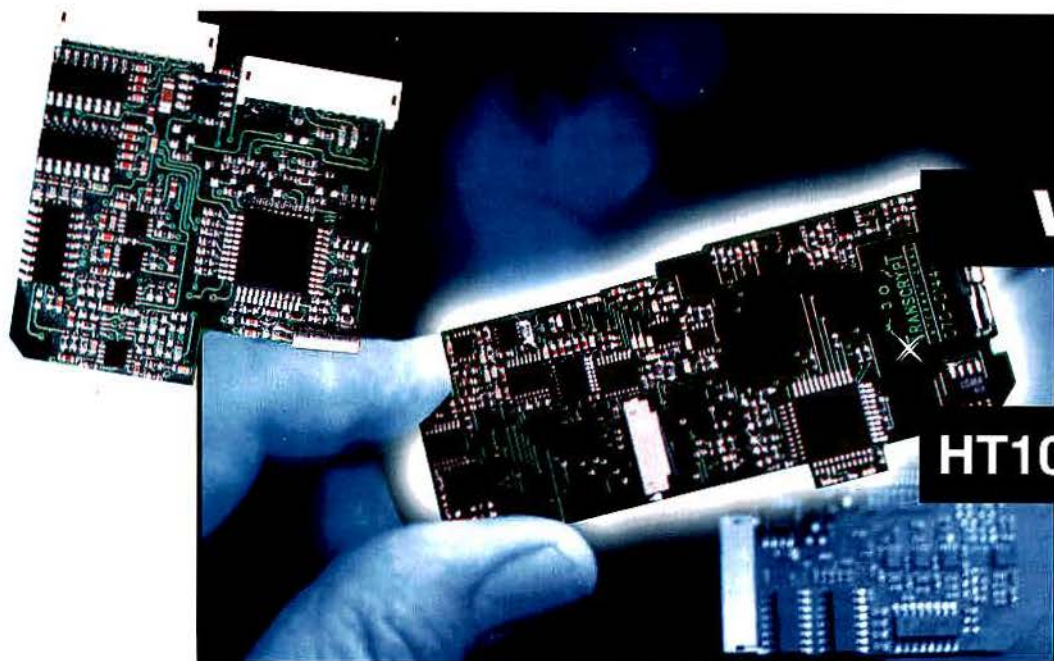
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On the cover: Mt. Tamalpais, a two-way telecommunications site serving the greater San Francisco-Oakland area, rises more than 2,500 feet above the shores of the San Francisco Bay. Photo courtesy of Diablo Communications, Point Richmond, CA.

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Personal communications attracts money, mergers



All eyes locked on dollar signs as the first FCC spectrum auctions netted \$617 million for narrowband personal communications service (PCS) licenses.

The July 25-29 auction at the Omni-Shoreham Hotel in Washington, DC, was predicted to bring \$20 million or \$30 million or maybe a little more. The final figure is at least 15 times as much.

Paging Network of Virginia (PageNet) bid \$197 million to win three licenses for 250kHz of spectrum. Did PageNet overspend? Here is an analysis by John L. Bauer II and Brian G. Coleman of the Lehman Brothers research and investment banking departments:

"PageNet should be serving roughly four million subscribers by year-end 1994. If the company continues to grow at a one million subscribers-per-year pace, it should be serving about 10 million by the year 2000. Assume that approximately 20% of these subscribers elect to subscribe to VoiceNow (PageNet's voice paging service, which will be deployed on the company's recently acquired narrowband frequencies) at a monthly service price of about \$15. This service would generate \$360 million in revenues. Apply a 45% cash-flow margin to these revenues, and VoiceNow could be expected to generate \$162 million in cash flows. At 10 times cash flow, the public market value of VoiceNow would top \$1.6 billion."*

Bauer and Coleman acknowledge the new system's enormous capital costs. Yet even with hundreds of millions of dollars to be spent in building the network and financing the pagers, "the return on this one service could be staggering," they wrote.

*PCIA Bulletin, Aug. 26, 1994.

Will the new narrowband PCS paging services compete with existing one-way paging services? The fact that current one-way paging licensees, such as PageNet, are planning to offer advanced paging services indicates that the new services will add value, extending more services, rather than replacing the existing services.

The yet-to-be-auctioned broadband PCS spectrum will carry portable and mobile telephone service. Will PCS telephone compete with cellular telephone? Probably. The difference between the competitive nature of PCS paging and PCS telephone may be reflected in the auction prices. The "15 times" factor may not apply to the actual vs. the expected take in the wideband PCS auction.

Does it matter that the government's estimate of auction proceeds is wildly different from the actual proceeds? Probably not. The FCC does not get to keep the money; it goes directly to the U.S. Treasury. Congress gives the FCC what it wants it to spend, regardless of what the FCC collects. Sure, some of the golden glow from the auctions may translate into some extra cash from Congress. But the FCC's survival is not at stake—as it can be for a business—when it comes to forecasting revenue.

Some administration officials will want to include auction proceeds estimates as part of next year's budget deficit reduction. We can hear it now: "If narrowband PCS spectrum brings \$617 million, surely wideband PCS spectrum will bring \$20 billion."

Back on Earth, the next auctions will bring what they bring.

PCIA-NABER merger: Done deal?

It is almost a done deal, the proposed merger of the National Association of Business and Educational Radio (NABER) into the Personal Communications Industry Association (PCIA).

The combined association is expected to have seven membership sections: paging and narrowband PCS; broadband PCS; specialized mobile radio (SMR); wireless system integrators; users; technicians; and site owners and managers.

The section most difficult to understand is "users." It once was easy to define the users that NABER represented, that is, licensees in the Business Radio Service. Those included individuals and companies engaged in the operation of a commercial activity; the operation of educational, philanthropic or ecclesiastical institutions; clergymen activities; and the operation of

hospitals, clinics or medical associations.

The rest of the sections are composed of individuals and companies that would like to sell goods or services to these licensees, the "users." There is a conflict of interest in trying to represent both buyers and sellers.


Moreover, there is another conflict of interest when one association represents public communications service-providers (SMRs, paging companies and PCS telephone companies) that want to acquire spectrum for resale, and businesses that want to acquire the same spectrum for their own direct and private use.

Then there is the matter of frequency coordination. One reason NABER is certified to coordinate the Business Radio frequencies is its perceived representation of the licensees. That representation is going to be substantially diluted in PCIA. This merger might stimulate a re-examination of the new PCIA's certification to coordinate frequencies for the Business Radio Service.

The whole matter of frequency coordination deserves attention, anyway, and now might be the time. As things stand, license applicants have no clear place to resolve disputed frequency assignments. According to the FCC, NABER works for the applicants. According to NABER, it works for the FCC. With neither the FCC nor NABER declaring responsibility for applicant satisfaction, yet with the FCC requiring applicants to use NABER, it is not hard to understand why dissatisfied Business Radio Service licensees find nowhere to turn.

Communications service-providers and private system licensees are entitled to the best trade association representation they can get. We have to wonder whether the private system licensees will be well represented within the same organization that includes billion-dollar-size service-providers with interests that often are in conflict with their own.

—Don Bishop

A black and white photograph of a man in a suit, looking intently at several large chess pieces (pawns and a king) that are in the foreground. The lighting is dramatic, with strong highlights and deep shadows.

EXPANDING YOUR PAGING NETWORK IS A LOT LIKE PLAYING CHESS...

...you have several options, but some choices make more sense than others.

As your paging network grows, every move is crucial. Your company's future depends upon the solid business decisions you make today.

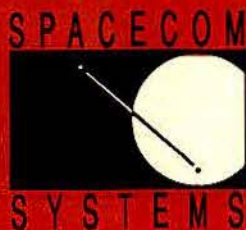
What's the best way to link your transmitter sites? You've played this game awhile, so you know your options. In the last few years, satellite technology has come to the forefront as one of the most cost-effective methods of linking transmitter sites.

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- 19-21—**International Wireless Communications Expo/Fall**, Tampa Convention Center, Tampa, FL. Contact: 800-828-0420.
- 26-28—**Manufacturers Radio Frequency Advisory Committee (MRFAC) fall meeting**, Hotel Gettysburg, Gettysburg, PA. Contact: Stephen Kress, 703-318-9206.

November

- 3-5—**Industrial Telecommunications Association and Council of Independent Communication Suppliers Annual Meetings**, The Kingsmill Resort and Conference Center, Williamsburg, VA. Contact: Barbara J. Levermann, 703-528-5115.
- 10-13—**Communications Marketing Conference**, sponsored by the Communications Marketing Association, Radisson Plaza Lord Baltimore Hotel, Baltimore, MD. Contact: Jack Armstrong, 410-628-9300.
- 18—**Radio Club of America**, Communications Symposium, 85th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

December

- 6-8—**Wireless Datacomm Fall**, Washington Convention Center, Washington, DC. Contact: 800-322-9332.

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January

- 16-18—**Mobile Communications Conference**, sponsored by Frost & Sullivan, Westin Hotel, Galleria Dallas, Dallas. Contact: 800-256-1076.

February

- 1-3—**Cellular Telecommunications Industry Association Winter Meeting and Exposition**, New Orleans. Contact: 202-785-0081.

March

- 13-14—**AMTEX**, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, The Buttes, Tempe, AZ. Contact: 202-331-7773.
- 16-17—**Government Land Mobile Communications Conference**, sponsored by TMSA Conferences, Rosslyn Westpark Hotel, Arlington, VA. Contact: Steven Silver, 310-534-4871.
- 20-23—**Supercomm**, sponsored by USTA and TIA, Anaheim Convention Center, Anaheim, CA. Contact: 202-326-7300.

April

- 3-5—**Energy Telecommunications and Electrical Association**, George R. Brown Convention Center, Houston. Contact: 214-235-0655.
- 25-27—**International Wireless Communications Expo/Spring**, Las Vegas Sands Convention Center, Las Vegas. Contact: 800-828-0420.

May

- 17-19—**Mobile Communications Conference**, sponsored by the National Association of Business and Educational Radio (NABER), Hotel del Coronado, San Diego. Contact: Nancy Palleschi, 800-759-0300.
- 30-June 2—**Radiocomm**, Toronto Metropolitan Convention Center, Toronto. Contact: 613-233-4888.

July

- 26-28—**Vehicular Technology Conference**, sponsored by IEEE Vehicular Technology Society, Hyatt Regency Chicago O'Hare, Chicago. Contact: Keith Paglusch, chairman, 312-399-2378.

August

- 13-18—**Association of Public-Safety Communications Officials—International National Conference**, Detroit. Contact: 800-949-2726.

September

- 20-23—**Personal Communications Showcase**, sponsored by the Personal Communications Industry Association (PCIA), Orange County Convention Center, Orlando, FL. Contact: 800-326-8638.



Mobile Radio Technology

The journal of mobile communications technology

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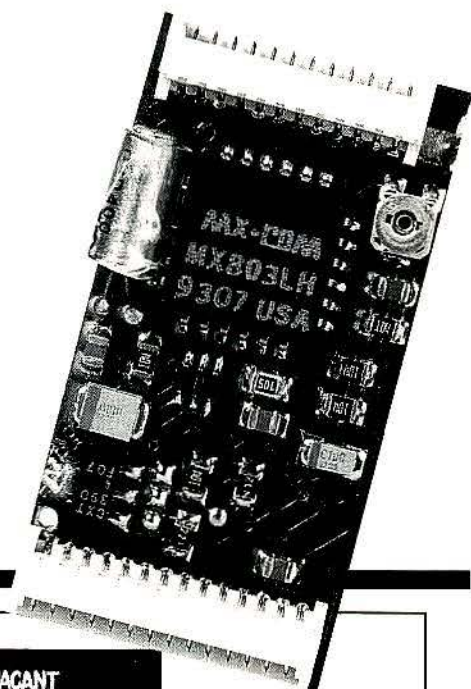
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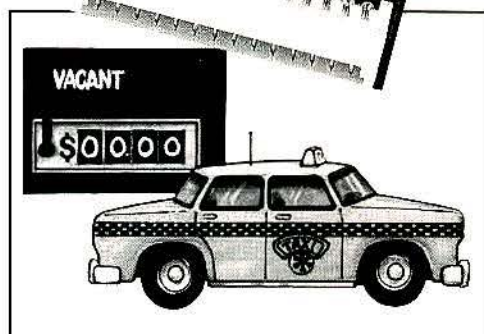
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Telephone line-testing basics, part 1

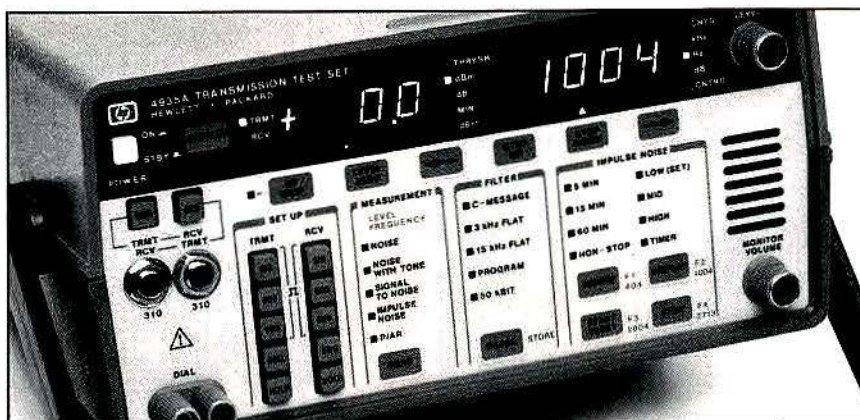


Photo 1. A transmission impairment measuring set (TIMS) can be used to measure all important performance characteristics of the telco line. Courtesy Hewlett-Packard.

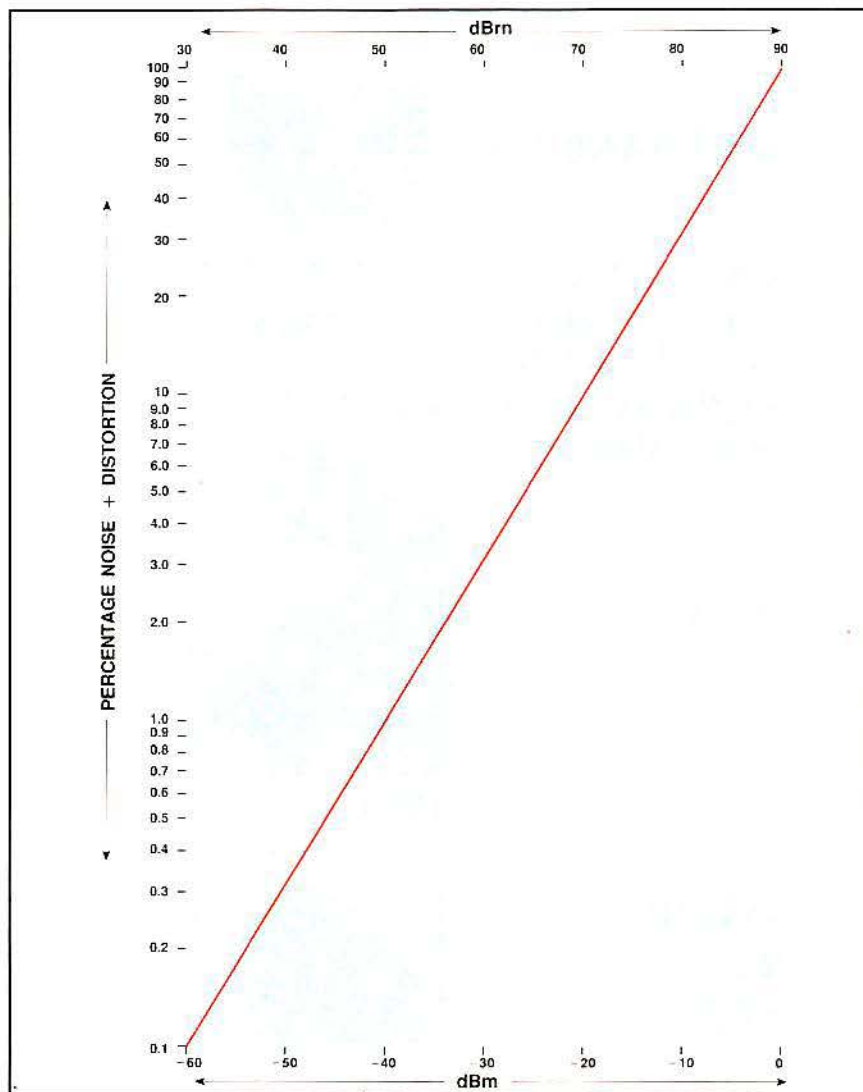


Figure 1. This graph correlates dBm, dBm and percentage of noise + distortion. This is based on a composite (signal + noise + distortion) signal level of 0dBm. Thus, if the 1,000Hz tone (signal) is removed from a 0dBm composite signal and the remaining noise + distortion is -20dBm or 70dBm, then the percent noise and distortion in the composite signal is 10%. The graph applies to the use of the instrument shown in Photo 1.

By Harold Kinley, C.E.T.

Normally, it is not a two-way radio technician's job to repair telephone lines used to remotely control radio communications equipment. However, before calling telco (the telephone company) to repair the line, a technician should perform the necessary tests to be sure that the trouble is in the telephone line and not in the equipment connected to either end of the line.

Often, telco employees do not understand radio system requirements, which is why thorough tests sometimes must be performed to obtain information that will communicate to telco the specific nature of the problem. Some of the basic telephone line measurement techniques are presented here.

Noise

It is important that telephone line noise be kept to a minimum, especially when low-level control tones are transmitted over the line.

A noise level of -90dBm has been established as the reference noise level by which other noise levels are gauged. Theoretically, this is the minimum noise level that can be heard by the average telephone user. This level includes the response of the telephone equipment itself. It is called the 0dB reference noise level, or 0dBm level.

Figure 1 to the left shows the correlation between dBm, dBm and distortion (and noise) levels. Photo 1 above shows a specialized test instrument not normally used by two-way radio technicians. It is a transmission impairment measuring set, or TIMS. It can measure all of the essential characteristics of a telephone line. It measures line noise in dBm or dBm.

continued on page 54

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

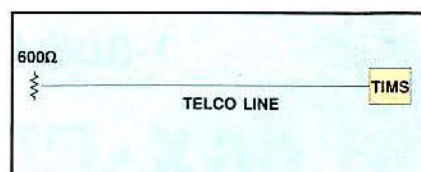


Figure 2. This diagram shows how to connect a transmission impairment measuring set to measure telco line noise level.

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A photograph of a radio tower site on a hill. In the foreground, several tall metal towers with multiple antennas are visible. Behind them is a large, dome-shaped building with a dark roof. The site is surrounded by green vegetation and a clear sky. The background shows a hilly landscape with some buildings and a body of water.

Taking the mystery out of combining

Site users are demanding ever-improving service from site operators. Combining allows operators with sites currently or potentially afflicted with equipment congestion to provide the most sophisticated service.

By Phil Jachowski

Something's got to give!

Paging is booming, specialized mobile radio (SMR) is expanding, and demand for building and tower space has never been greater. To the site manager this ought to be good news, and it is—except for a few troublesome points:

How do you fit more radios into a communications site?

How do you install more antennas on the tower?

How do you deliver signals at a price the market will accept?

The problems in dealing with planning commissions preclude many operators from adding to their mountaintop or building rooftop facilities. It is tough enough facing the environmental, city, state and federal boards once, let alone returning to request permission to build *another* wing on an existing structure or to put up a *second* tower.

Pity the poor towers—often designed for a handful of antennas—that can grow to look like an erector set with an attitude! This type of growth, if not monitored and controlled, can lead to a tower with severe aesthetic, mechanical loading, space and RF interference problems.

Fortunately for the site manager and equipment owner, technology has been

successful in shrinking the size of radio equipment. This, to some extent, helps to ease the building's space constraints and often can mean lower rental rates to the equipment owner. To ease the burden placed on the tower, though, there is currently no better alternative than carefully designed combining systems.

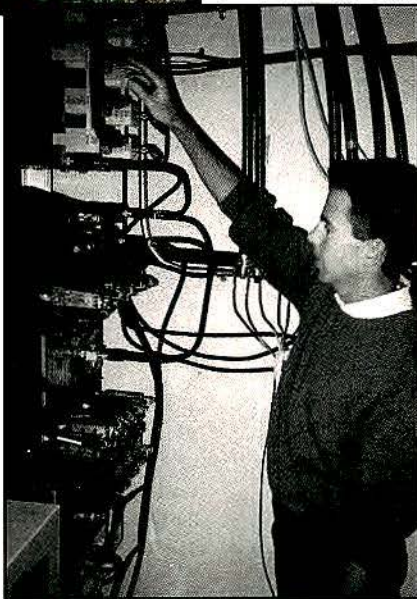
Combining is simply the technique of using one antenna for multiple transmitters in a common frequency grouping and a second antenna for multiple receivers in a common frequency grouping. The ad-

vantages are obvious: Fewer antennas serving multiple radios can save space, save money and serve both the equipment owner and site manager efficiently. Instead of 10 antennas and feedlines for 10 radios, for example, one transmit and one receive antenna with "combining" could serve the purpose. All this is possible if the combining system is engineered, installed and maintained properly. That "if" is what has given nightmares to some and caused others to dig in their heels and say "no" to combining.

In a typical combining operation, the output of each transmitter is fed to an isolator that is followed by a high-Q cavity resonator or ceramic resonator tuned to each transmitter's frequency. Each resonator's output is then combined into one output with the use of tuned cable assemblies and *n*-way junctions. The output of the *n*-way junction feeds a common transmission line, which, in turn, feeds a single antenna cut to a frequency range that includes all of the transmitter frequencies fed through the combiner. In theory, one may order a combining system from a reputable combiner manufacturer, install the equipment, plug in everything, turn on the power, and a group of frequency-compatible radios will be on the air as their owners enjoy the economies and technological efficiencies that result from a properly engineered combining system.

In practice, things can go wrong. When they do, the solid advantages of combining are often overlooked, and the technique can be given an undeserved bad name. What can happen?

(1) Problems can begin if a site operator and a user do not meet early enough to agree on the specifications for a new radio. Be sure that the combiner can handle the power output of the transmitter. A 150W power rating for paging transmitters used to be the norm, and combiners can usually handle that much power. Now, though, half-kilowatt paging transmitters are available that cannot be tuned below 250W output. Combining designs for these higher power levels are still being refined, although they are available. Work closely with the vendors to ensure that the combiner, coaxial cable, connectors and antenna will meet all the demands placed on them. Work closely with the user to negotiate and to engineer a system that will function. Remember to find out whether an appropriate isolator is included in the radio. If so, the additional cost can be avoided by deleting it from



The author checks a combiner at a Diablo Communications site.

Jachowski is director of engineering at Diablo Communications, Point Richmond, CA

the combiner port.

(2) Problems can occur after a system is installed if variables change from the original installation. Some users will "sneak" back to the site and increase power without informing the site manager. They succeed only in burning up the cavity or isolator.

If care is not taken to maintain appropriate frequency spacing when channels are added to an existing combiner, additional

signal loss and reduced isolation between transmitters will occur. Check with the manufacturer to find out what spacing is possible on the combiner you are using.

Keep in mind that, just because there is a problem with a radio that is connected to a combining system, the problem is not necessarily caused by the combiner. Other problems can occur whether combining is involved or not. One paging client told me, "Something's wrong with your system.

You're just not getting my signal out everywhere it's supposed to be. It must be the combiner. Either that or we need more power or more antenna gain—or something!"

Further troubleshooting proved that none of these possible causes actually were to blame for the problem. The system timing had been incorrectly set by the client, and areas of "no signal" resulted in areas where one transmitted signal canceled another.

Is there a limit on how many transmitters may be combined on a single antenna? Our company has had anywhere from two to 24 transmitters operating through a single combining system. The number of transmitters on a given combining system

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Keep in mind that, just because there is a problem with a radio that is connected to a combining system, the problem is not necessarily caused by the combiner.

typically is limited by three factors:

(a) the minimum frequency separation the combiner can accept.

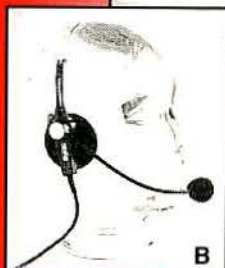
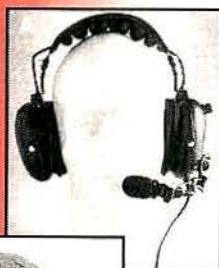
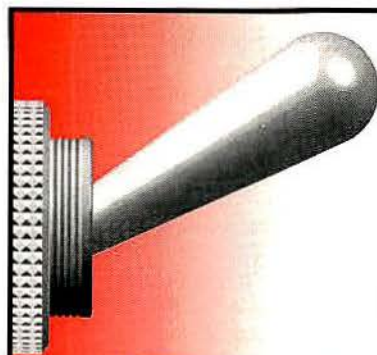
(b) the cumulative power and the capabilities of the antenna, connectors and coax to handle it.

(c) the antenna bandwidth.

Losses occur when transmitters are fed through combining systems—and when they are not. At Diablo Communications, if a user is not on a combining system, we require the use of an appropriate isolator and cavity on the transmitter output to protect other users' equipment at the site and to keep intermod sources to a minimum. Loss through the coax also is present regardless of the transmission method.

The user who insists on a dedicated antenna position on a tower should keep the following two points in mind.

(1) Most site managers reserve the prime antenna mounting locations on a tower for combining systems, thereby providing the best coverage to the highest possible number of users. When a potential user approaches a site manager or owner



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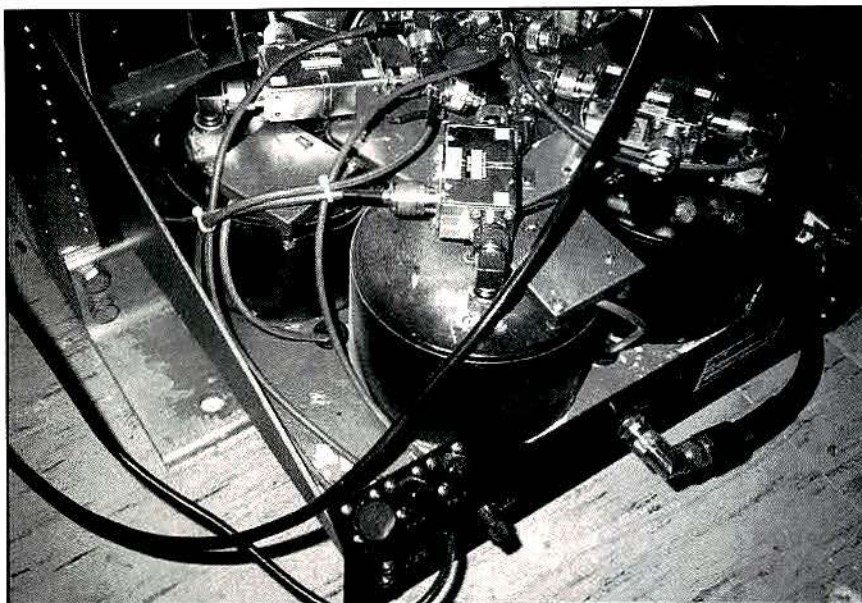
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900 MHz SMR FULL BAND	48522-N	935-941
BASIC CELLULAR A BAND	48549-N	869-891.5
ENHANCED CELLULAR A BAND	48550-N	869-891.5
BASIC CELLULAR B BAND	48543-N	880-894
ENHANCED CELLULAR B BAND	48551-N	880-894



An auto-tuned paging combiner with a ceramic-based resonator.

and insists on a dedicated antenna position on the tower, chances are the manager will do his best to give the user a location that will fit the coverage requirements, but the positioning may be compromised some-

what to preserve the best locations for "master antennas."

(2) Look at costs. Be prepared for an "install fee" or "antenna system fee" when attaching your radio to a combining sys-

tem, but do not be scared off by it. Look closely at what you get for your fee. Typically, the user will have to provide nothing more than the radio at a "combined site." The site manager, for a fee, provides the cavity, isolator, coax, connectors, antenna, mount and the labor to install everything from the output of the radio up to and including the antenna.

The benefits do not stop there. After installation, combining system maintenance typically is performed by the site manager. The user only needs to worry about maintaining the radio equipment. Given the variation of costs and systems nationwide, it is impossible to give a perfect example of the savings, so add the numbers and see the savings for yourself. The site manager hopes to break even on system costs while profiting from the added efficiencies of tower space management and added control over RF at the site.

Combining is viewed as "something for the future" or "an absolute essential," depending to some extent on whether the site operator is basically a real estate manager or a full-service operator. Those who lease real estate say, in effect, "Pay us \$75 a month and hang your antenna over there."

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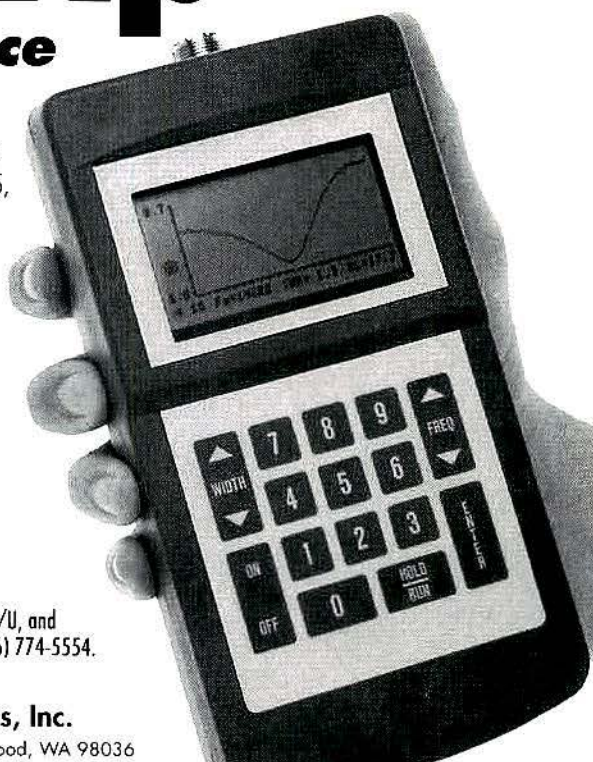


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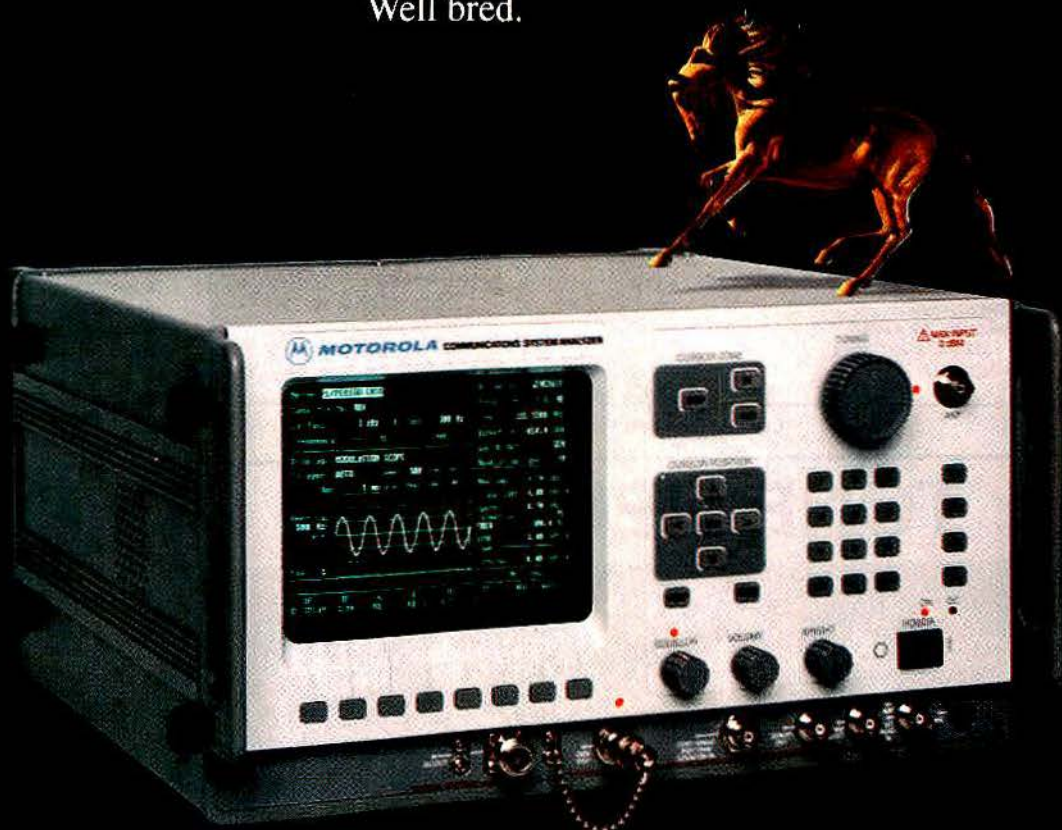
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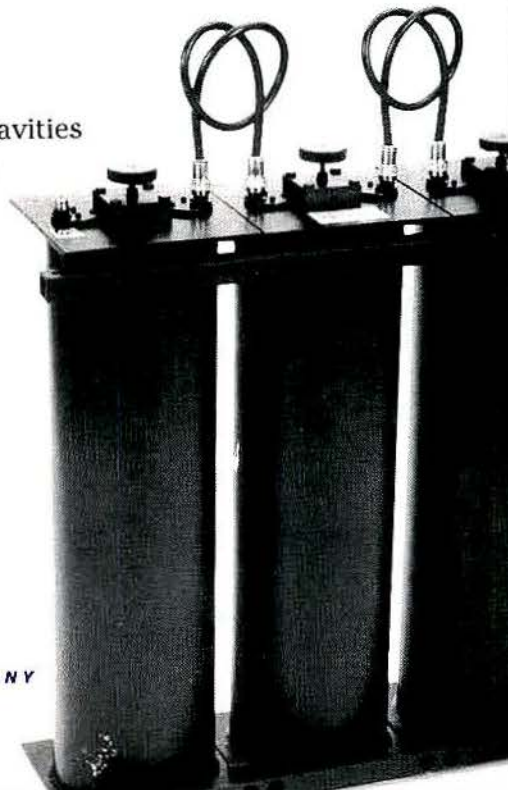
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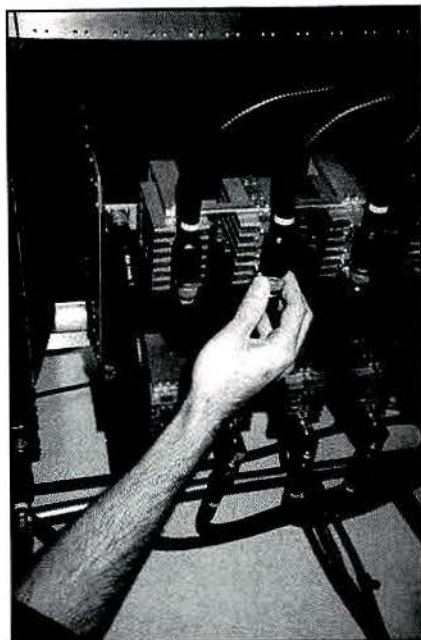


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Make sure all connectors are screwed on tight to avoid unwanted RF noise at a site and additional losses. It is also good practice to check periodically for hot isolator loads. A hot load is a sign of an untuned cavity, bad antenna or a transmitter putting out too much power.

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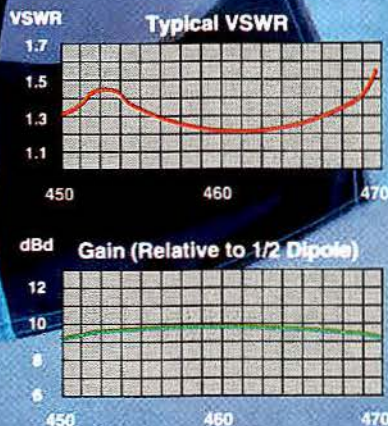
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Servicing pagers: Tales crystal filters tell . . .

Part 10—Tuning Bravo pager crystal filters to the high side of the first injection oscillator frequency results in proper operation. Here's why, plus some tips for making and verifying the adjustment.

By David Ludvigson

Crystal filters long have been used to reduce a received signal's bandwidth. As a rule, filters usually are adjusted to approximate a rectangular passband characteristic at the receiver's intermediate frequency to restrict detection to only that portion of the signal containing the desired intelligence.

Perhaps the best demonstration is the tuning of an AM broadcast radio with an analog dial. With the receiver tuned to the low side of the carrier frequency, a decent audio signal is heard. As the radio is tuned upward in frequency, a point is reached at which the fidelity of the recovered audio drops off. This point is the carrier frequency. The carrier does not contain any

audio information. Continuing to tune upward, once again a point of maximum fidelity is reached. This effect is especially noticeable if a narrow IF filter is used in the circuit ahead of the detector and amplifier.

An FM receiver's bandwidth (and the recovered information) may be restricted by use of an IF filter, with similar effects.

When placed in the path of a low-level signal, a properly terminated crystal filter passes only the fundamental frequency and a small portion of frequencies on either side of the fundamental. Depending on the construction and type of crystal geometry used to cut it, a crystal's bandwidth usually falls between 0.02% and 0.05% of the crystal frequency.

Several crystals of the same frequency may be configured to provide a narrower bandpass, but for the sake of discussion, we will limit the options to the 0.02% fig-

ures with respect to the Bravo receivers.

The mathematics

$$F_{\text{xtal}} \times 0.02\% = \text{bandwidth}$$

$$17.9\text{MHz} \times 0.02\% = 3,580\text{Hz}$$

$$45.0\text{MHz} \times 0.02\% = 9,000\text{Hz}$$

These figures determine the "window" or bandwidth available through the associated 17.9MHz IF and 45.0MHz IF filters and agree quite closely with measured performance of the Bravo IF filters.

The signal radiated from paging transmitters is symmetrical. (See Figure 1 to the left.) On either side of the carrier frequency, the same intelligence is transmitted. "Normal" POCSAG is normal on both sides of the center frequency; "inverted" POCSAG remains inverted on both sides.

The crystal filter imposes a bandwidth factor that allows the quadrature detector to "see" that portion of the signal to which it has been tuned. This bandwidth factor may be adjusted by means of the first injection oscillator.

With a 9kHz window, the 45MHz IF boards are the easiest to tune, and they maintain their tuning for quite a long time. The narrower 3.58kHz window of the 17.9MHz IF filter is more critical of adjustment, and oscillator frequency drift causes reception of erroneous messages. Recalling that the maximum rate of data is 2,400bps and that the POCSAG signal preamble calls for a large portion of the overall "batch" to contain the "alternate 1 and 0" sequence, we are left with an IF window that must pass 2,400Hz to be of any value.

Next, consider the FM detector. Regardless of its design, an FM demodulator responds with an output voltage polarity determined by whether an input signal is higher or lower than the center frequency.

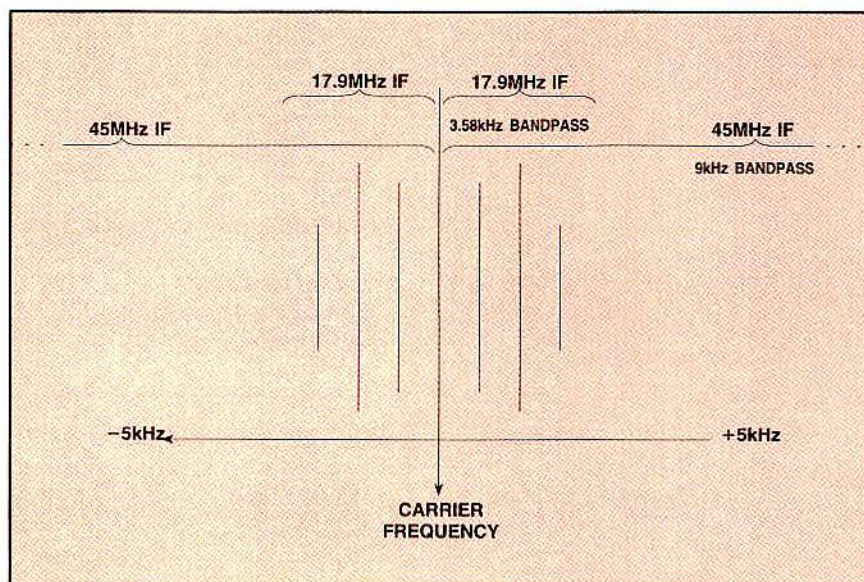


Figure 1. The signal from the paging transmitter is symmetrical. The paging receiver must be tuned to place the IF bandpass where it will do the most good. See text.

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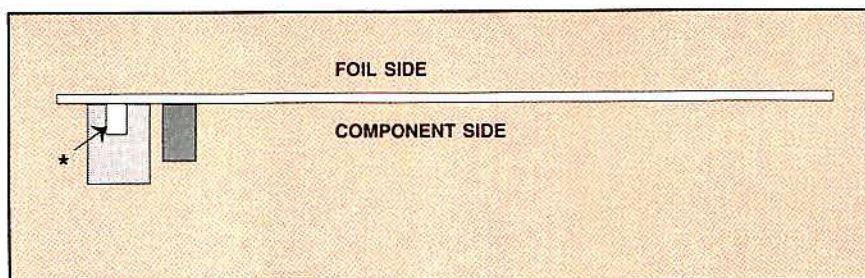


Figure 2. A side view of the Bravo receiver board. Start with the oscillator core fully up (at circuit board level) when adjusting it to frequency.

In short, careful adjustment of the first injection oscillator frequency might result in failure to decode a received message! Placing the Bravo pagers (all of them) on the high side of the first injection oscillator frequency results in proper operation. This fact means that the core of the oscillator coil should be set to the first peak as you adjust the core from the circuit board plane to the top of the coil form. (See Figure 2 above.)

Further advancing the core (downward, as viewed by the operator) causes the IF window to move lower in frequency, toward the carrier frequency, and if advanced further, toward the "unwanted

side" of the FM signal.

When testing my tuning, I usually use a 134Hz tone that modulates the signal generator to 3.5kHz deviation. Using the IFFER, I can quickly determine proper tuning by noting symmetrical response above and below the oscilloscope's horizontal line. (See Part 2: "Build An 'IFFER,'" February 1994 issue.) At 134Hz, I am testing the low-frequency response of my filter, and by setting it symmetrically, I am moving the bandpass completely off the "unwanted" side. Audible output from the IFFER also reveals a more resonant response to the 134Hz signal when tuned in this fashion.

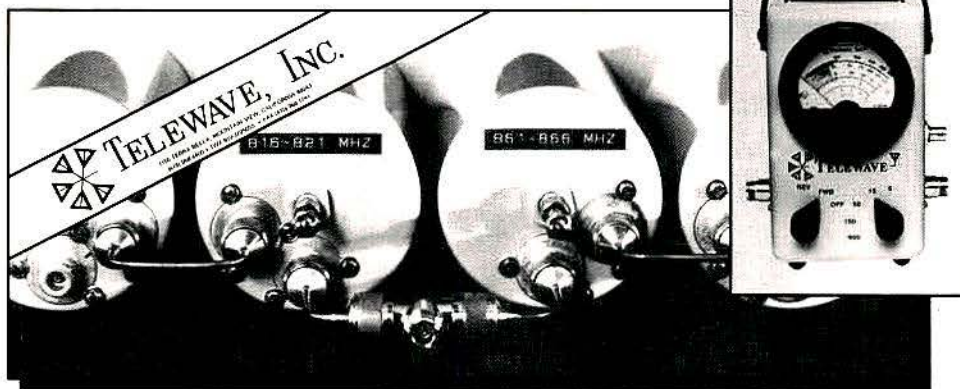
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- Part 2: "Build An 'IFFER,'" February 1994. (Bravo, Bravo Plus, Bravo Express.)
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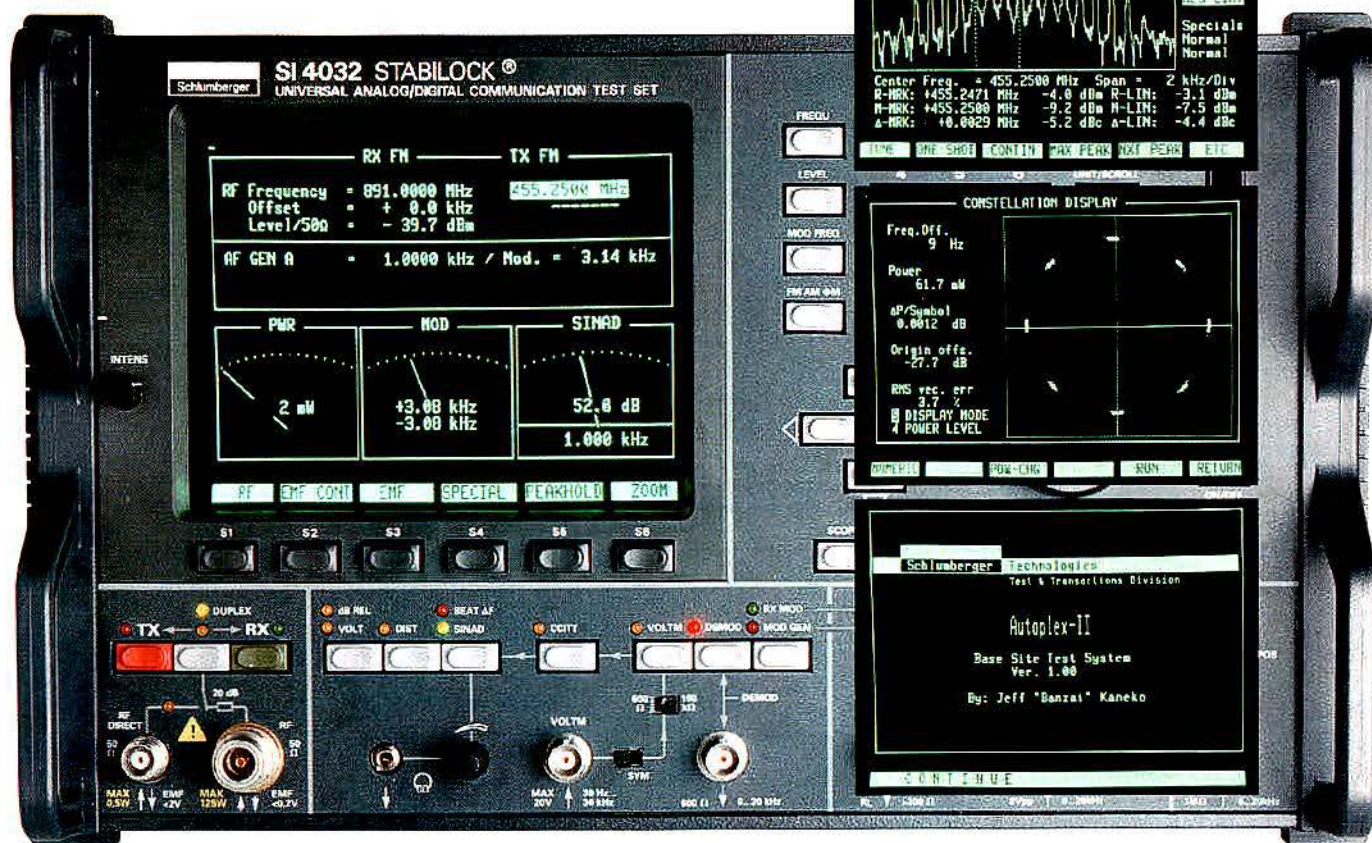
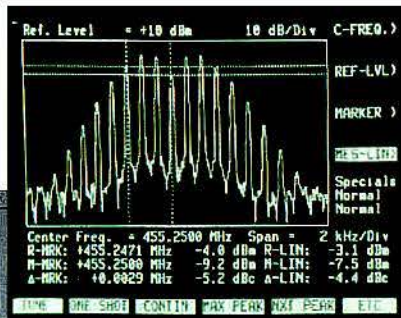
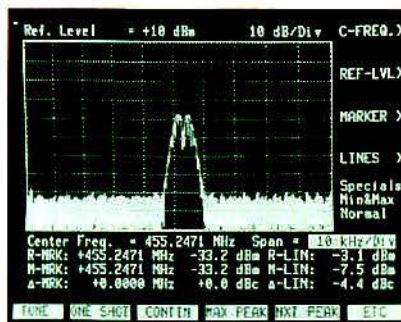
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How to use duplexers: Fine-tuning adjustments

Part 4—After initially tuning a filter using a spectrum analyzer and the technique described in Part 3, follow these fine-tuning steps to finish the job. Inexpensive test equipment can be used.

By Brian J. Henderson, P. Eng.

The best method for tuning filters uses thousands of dollars worth of test equipment.

Another, less expensive method, uses a transmitter, receiver, directional wattmeter and signal generator. One or more dummy loads may be required for a duplexer's unused ports.

Several rules and facts apply to this tuning method.

(1) All duplexer ports, whether or not they are connected to a signal generator, transmitter or receiver, must be terminated in a 50Ω impedance.

This rule cannot be stressed enough. Failure to follow this one simple rule results in poor filter tuning and poor system performance.

(2) When tuning any bandpass cavity, the lowest SWR point occurs at the passband frequency.

Henderson is senior engineer, communications, with Canadian Western Natural Gas, Calgary, Alberta.

(3) Once the tuning rod is adjusted for the correct frequency in a pass or reject cavity, capacitor adjustment does not affect this tuning.

That is, once the tuning rod is set for pass frequency, this adjustment is not affected further by adjustment of the tuning capacitor, other ports of the duplexer string or other cavities.

Bandpass Duplexer

The first type of duplexer to be tuned is the bandpass duplexer. There is only one

adjustment per cavity. Connect transmitter, wattmeter and terminations as shown in Figure 1 below.

Set the transmitter to the correct pass frequency. Transmit into the duplexer string and adjust the tuning rods for minimum reflected power as indicated on the wattmeter. Note that reflected powers should be less than 1W, so it may be advisable to use a low-power wattmeter element.

Tune each bandpass cavity in the above manner. Then assemble all bandpass cavities together into the correct duplexer configuration. Fine-tune the transmit side as shown in Figure 2 below left.

Then reverse the transmitter and load connections. Set the transmitter to the receive frequency and adjust the receive side in the same manner. It is perfectly acceptable to transmit into the receive side of any duplexer, providing all terminations are in place and the receiver is not connected.

As a check for proper isolation, connect the signal generator, receiver and terminations as shown in Figure 3 below right. Set the signal generator and receiver to the same frequency.

Inject the signal into the duplexer antenna port. In this example, the signal

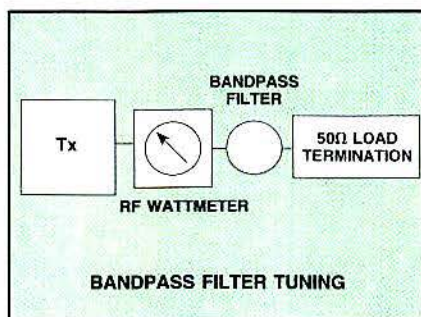


Figure 1. To configure equipment for tuning a bandpass duplexer, connect a transmitter, a wattmeter and terminations as shown.

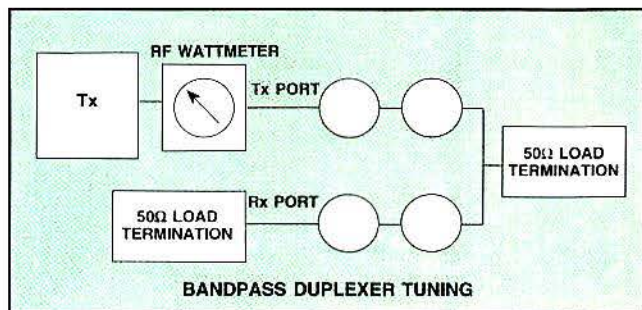


Figure 2. After tuning each bandpass cavity individually, assemble them into the correct duplexer configuration. Fine-tune the transmit side as shown. Then reverse the transmitter and load connections. Set the transmitter to the receive frequency and adjust the receive side in the same manner.

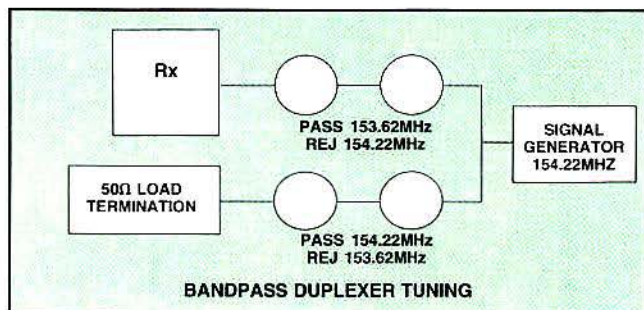


Figure 3. As a check for proper isolation, connect the signal generator, receiver and terminations as shown. Follow steps described in the text to measure the duplexer isolation.



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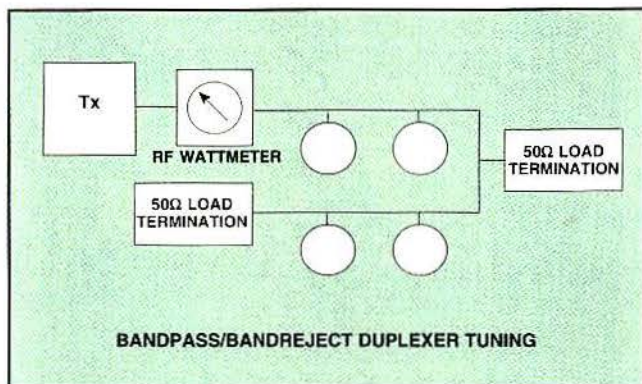


Figure 4. Steps for tuning the bandpass/bandreject duplexer are similar to those for the bandpass duplexer. Set up the duplexer as shown, and follow the steps described in the text.

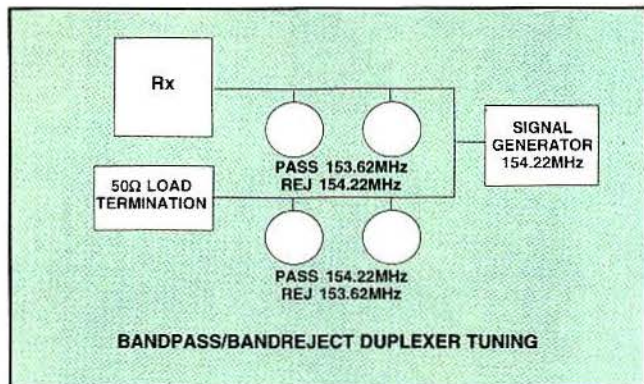


Figure 5. Use this equipment configuration to measure the receiver noise threshold in Step 2 of the bandpass/bandreject duplexer adjustment procedure.

generator and receiver are set to 153.62MHz. Determine receiver *noise threshold* (the point where noise begins to disappear). Record this reading in dBm.

Move the signal generator to the duplexer transmit port. Retune the signal generator and receiver to 154.22MHz. Increase generator output until the same noise threshold point is found. Again, record the generator output level in dBm.

The difference between these two levels

is the duplexer isolation in dB at that frequency.

Bandpass/bandreject duplexer

Tuning this type of duplexer is similar to the bandpass type.

Two adjustments are made on each cavity, the tuning rod and the capacitor adjustment. Set up the duplexer as shown in Figure 4 above left. In all cases, bandpass tuning rods are adjusted first; capacitors are

adjusted last.

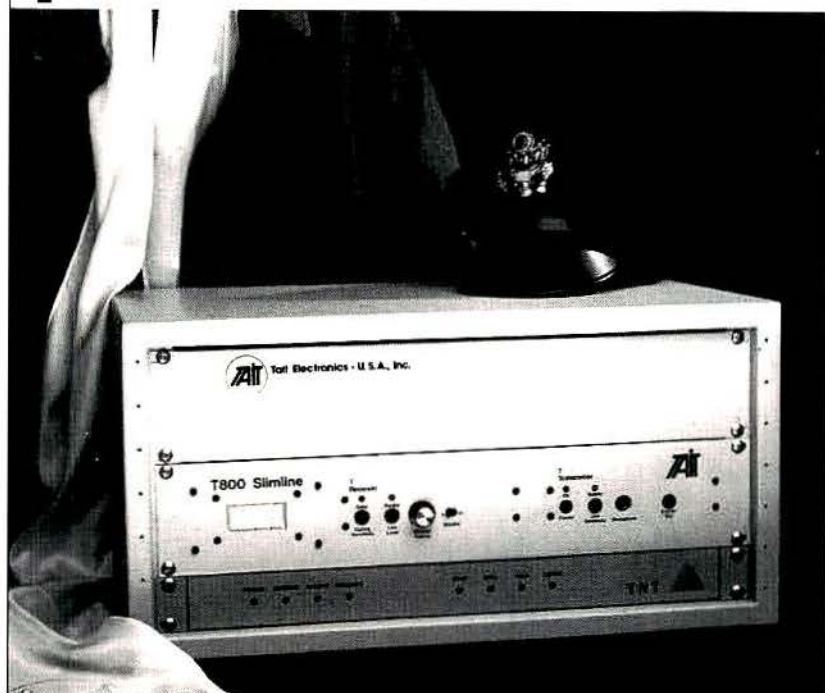
(1) Transmit into the duplexer on the correct frequency.

Adjust the tuning rods for minimum reflected power. Tune both "sides" of the duplexer—transmit and receive—on the correct frequency.

(2) Connect the signal generator to the antenna port. (See Figure 5 above right.)

Inject signal on the other frequency and adjust the capacitor for maximum rejection

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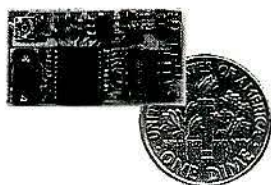
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of this signal.

Open the receiver squelch.

Increase signal generator output until normal FM quieting is heard. Reduce generator output until noise returns. This is referred to as the receiver *noise threshold*.

(3) Adjust the capacitor for maximum noise as heard in the receiver. (This point represents the maximum attenuation of signal from the signal generator.)

(4) Keep increasing generator output and

adjusting capacitors until no further increase in rejection can be obtained.

(5) Repeat this process for the other "half" of the duplexer string.

You may find one of these types of duplexers impossible to tune. If so, check the duplexer with a spectrum analyzer and tracking generator. The duplexer may have been "flipped" from a highpass to a lowpass or vice versa. See Figure 6 to the right for the proper appearance of highpass and

lowpass curves as shown on a spectrum analyzer display.

Remember that tuning a duplexer with a spectrum analyzer is *approximate*. Duplexers must be *fine-tuned* with the transmitter and receiver technique detailed above.

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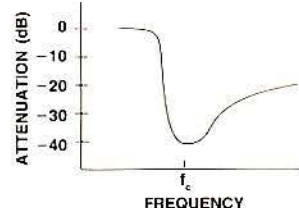
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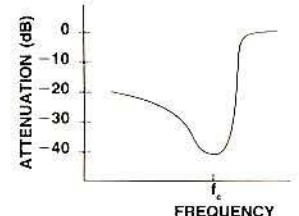
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(A) FREQUENCY RESPONSE LOWPASS CAVITY



(B) FREQUENCY RESPONSE HIGHPASS CAVITY

Figure 6. The spectrum analyzer display for a lowpass curve should look like curve (A), and the highpass curve should look like curve (B).

Next: Transmitter combiners and receiver multicouplers allow multiple repeaters to share the same antenna. If the system can tolerate the energy loss, combiners allow more efficient use of antenna space.

Duplexer series

Previous installments in this article series include:

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- "How To Use Duplexers: The Various Types" in the August 1994 issue.
- "How To Use Duplexers: Installing and Tuning" in the September 1994 issue.

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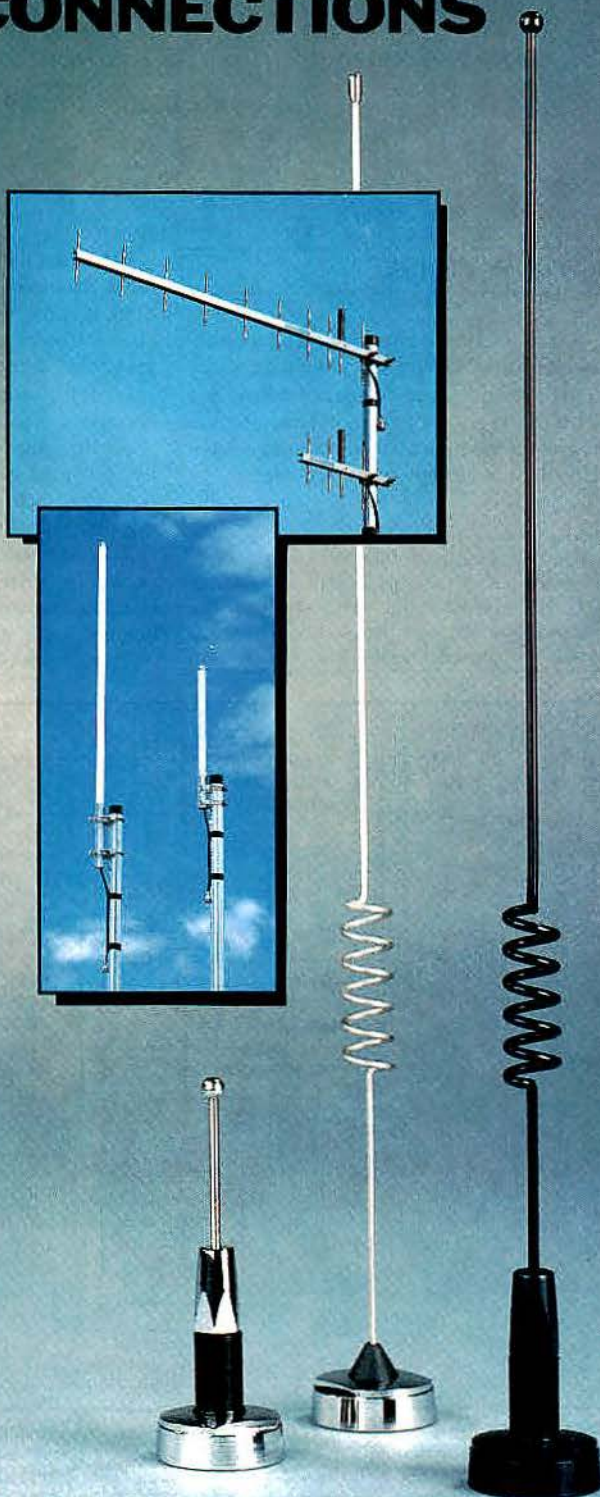
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Interconnecting trunked and conventional systems

Interconnect a wide range of conventional, analog and digitally based trunked systems together, without requiring 'super' mobiles capable of all of the combined functions of the different networks.

By Frits P. Van Enk

Many factors have influenced private mobile radio service development, especially limited frequency availability and "line-of-sight" coverage limitations. Rapid technological advancements have helped to surmount these problems.

Van Enk is managing director, Radio Systems Technologies, Springvale, Victoria, Australia. Tel. +61-3-547-0200; fax +61-3-546-4676. The company manufactures the eXeLink crossband system described in this article.

Trunking, the technique of sharing many radio channels among numerous users, and tight control over radio frequency (RF) characteristics to reduce interference and maximize frequency reuse largely have solved the original problem of limited spectrum.

At the same time, trunking technology has provided an impressive range of new functions such as automatic calling, calling party identification, data transmission, call diversion, private automatic branch exchange (PABX) and/or public switched telephone network (PSTN) access and, last but not least, wide-area coverage.

Trunking is completely changing mobile

radio and is affecting the prospects and scope of conventional (non-trunked) mobile radio applications.

Effect on conventional systems

The desirability of trunking does not necessarily mean that conventional radio will become obsolete.

A dedicated, exclusive frequency has some specific advantages that cannot be easily matched by the current trunking technology, if at all. A dedicated *open channel* offers instant access without any delays required for call set up and pre-call switching in trunked systems. A dedicated channel is never "busy" in the sense of

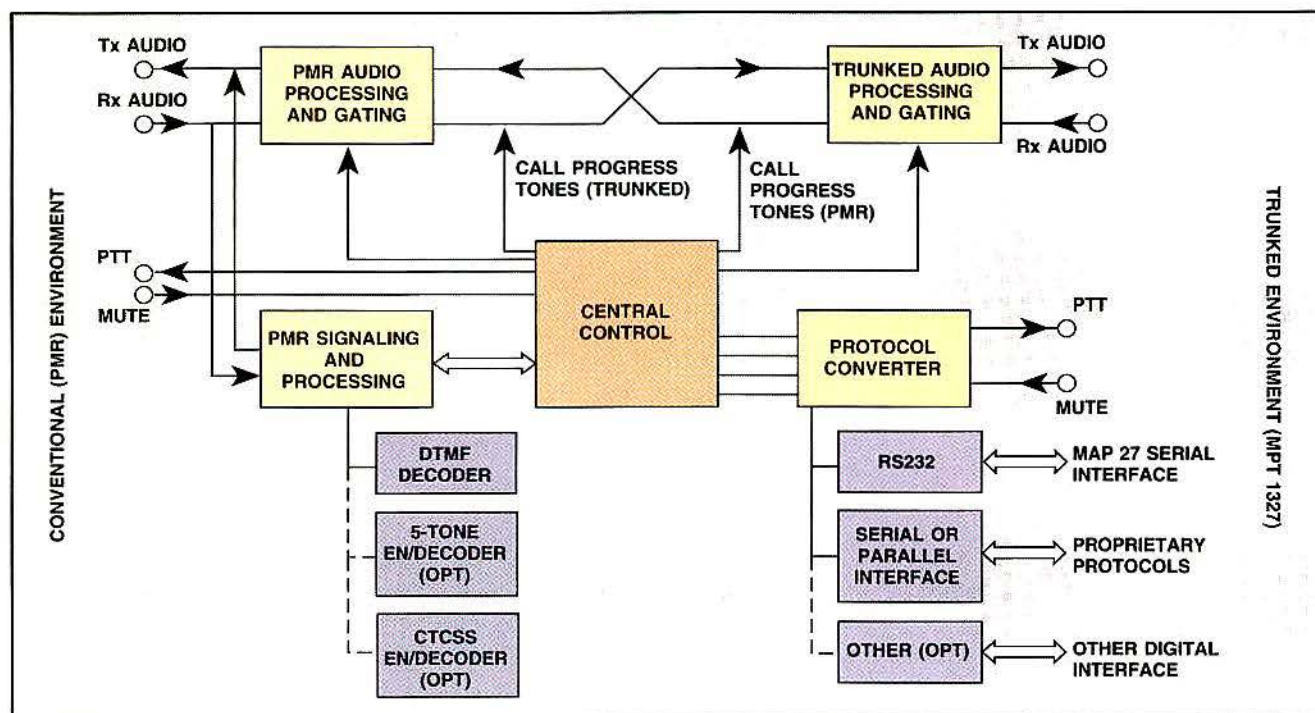


Figure 1. The basic crossband system block diagram. The crossband system decodes incoming call connect requests from a conventional repeater system and converts them to a trunking-compatible format while managing all switching, call-progress tone generation and other call

setup and maintenance functions. Trunked mobiles may connect to the conventional system by dialing the number of the (fixed) trunked radio that is connected to the system.



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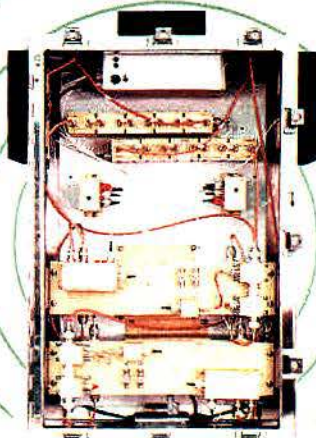
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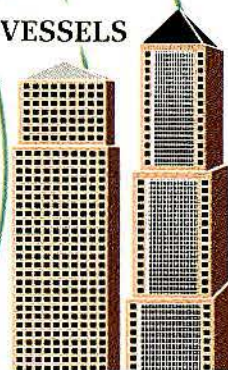


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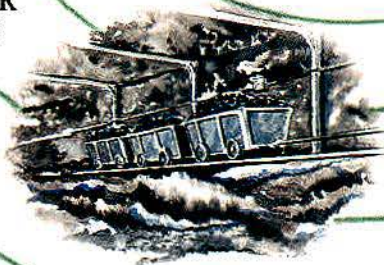
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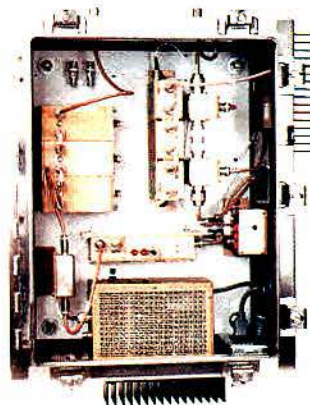
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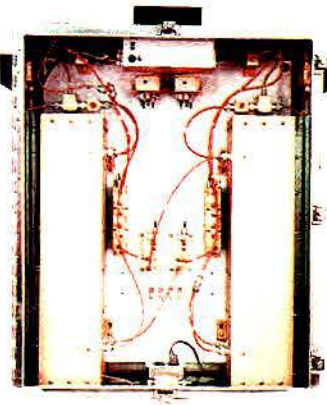
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"temporarily unavailable due to congestion" as in trunked systems. Even if and when guaranteed instant access may be available under certain conditions in certain trunked systems, such access usually is undesirable from a general system operational point of view, because instant and unrestricted access goes against the very principle of trunking.

Most mobile radio users can, and will, live happily with short call setup delays. Even when access is temporarily unavailable, modern trunked systems' sophisticated call-queuing makes sure that calls go through despite occasional short delays.

In certain applications normal trunking delays are unacceptable or impractical, as in police and emergency radio networks, highway maintenance radio networks and various private networks with crane operators in dockyards and at construction sites.

Another reason for continued conventional radio demand is that even the largest wide-area trunking system always has coverage restrictions to some extent. Trunking infrastructure is so expensive that rural areas usually are either only partially covered, or not at all, for lack of a minimum customer base.

For economic and spectrum-efficiency reasons, even trunked systems in built-up areas do not always deliver coverage everywhere within the coverage perimeter, especially when it comes to portable radio coverage inside buildings and basements.

Moreover, dedicated, high-speed, centralized data dispatch systems may operate better on a dedicated channel to avoid trunked system call setup overhead.

Finally, under certain conditions, a dedicated-channel private system may be more economical to build and operate than the alternative of subscribing to a public trunked system service.

The need for interconnection

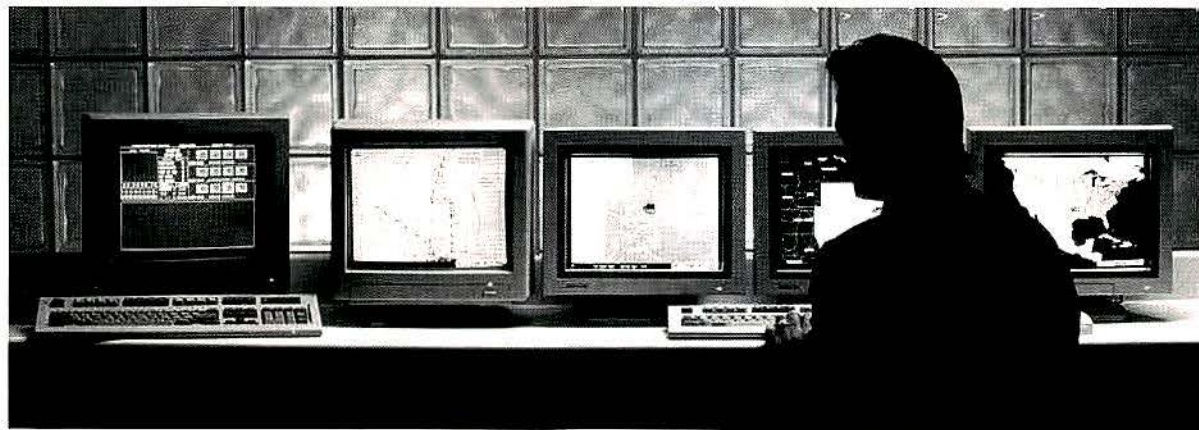
Dedicated-channel radio systems will continue to have an important place in radio communications, and even if many existing conventional systems eventually are replaced by trunked systems, the transition will take considerable time to complete.

Although the number of proprietary trunked system technologies is limited, there is no single global trunking standard. Common trunking systems include E.F. Johnson logic trunked radio (LTR),

Motorola Smartnet and the MPT1327/1343 system originally conceived and designed in the United Kingdom. MPT1327 has been widely adopted as a common trunking standard by most West European countries, South Africa, Southeast Asia, New Zealand, Australia, Indonesia and Fiji. MPT1327 is not necessarily used exclusively in those countries. In Australia, for instance, most states have adopted the MPT1327 system as the basis for wide-area or statewide trunked operations, but the State of New South Wales has adopted the Motorola Smartnet system.

In addition, trunked systems throughout the world do not necessarily operate on the same frequency channels and bands.

What is needed is a way to connect trunked and conventional systems without imposing any new or special requirements on existing radios and base control systems. One way is to use a "smart" cross-band system that decodes incoming call connect requests from a conventional repeater system and converts them to a trunking-compatible format while managing all switching, call-progress tone generation and other call



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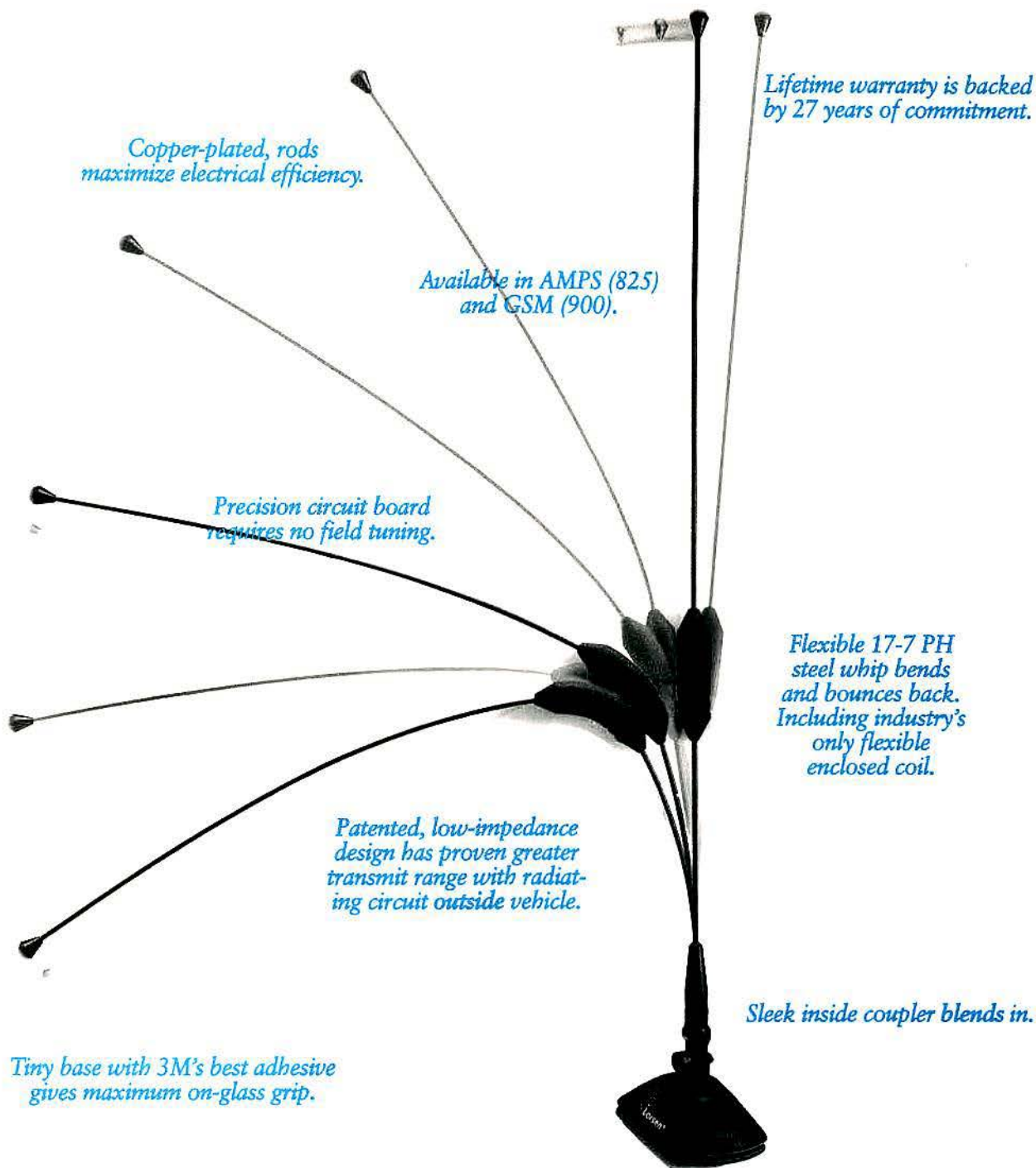
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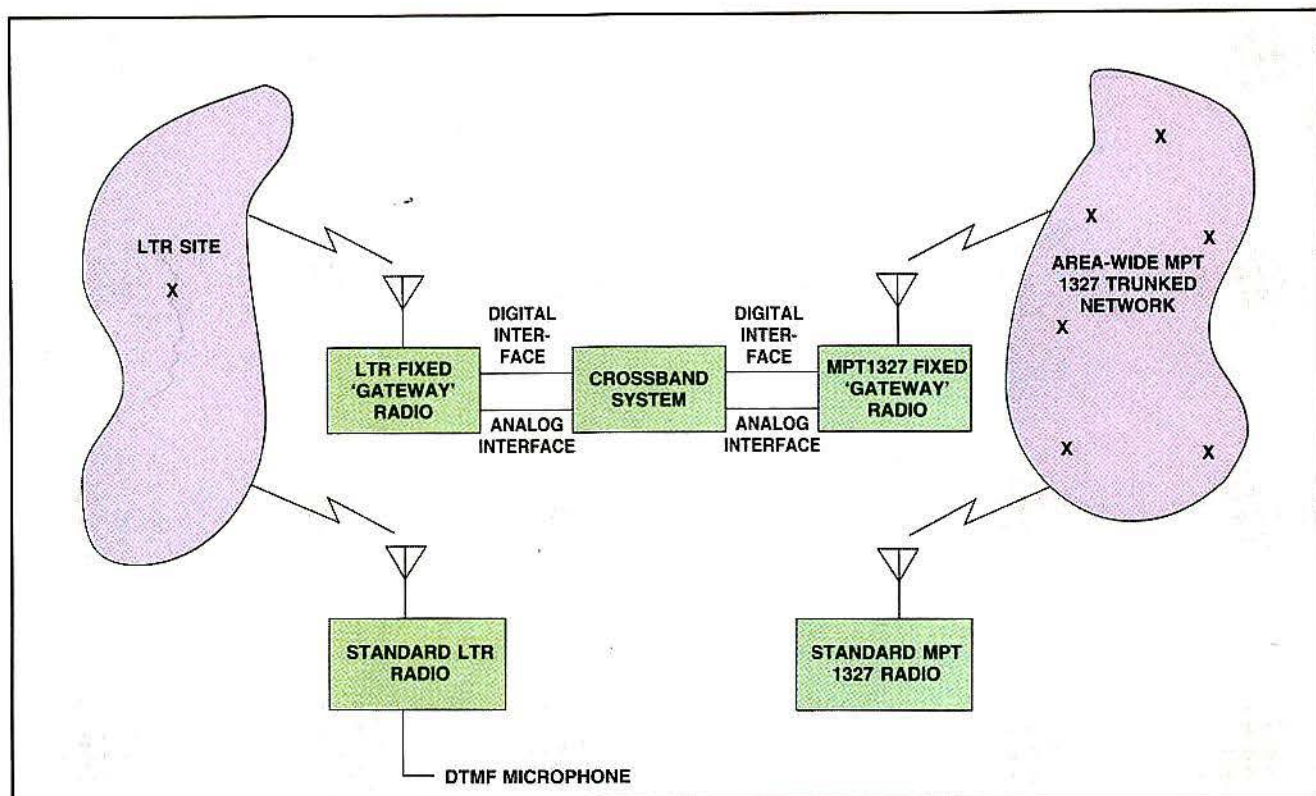


Figure 2. An existing LTR system is interconnected with a new MPT1327 system. LTR radios use DTMF to dial various MPT1327 addresses, and MPT radio users dial the crossband system address for automatic connection with the LTR fleet on a group basis. Alternatively, if they have DTMF over dial facilities, they may call individual LTR mobiles and/or groups of mobiles.

setup and maintenance functions.

Figure 1 on page 28 shows the block diagram of one such crossband system.

Signaling of some kind is needed to give the crossband system details about the required interconnection. For example, in an MPT1327 system, it would be the address of a subscriber, and in an LTR system, it would be the group identification of the fleet to be called.

The crossband system is designed to handle many incoming signaling formats, including continuous tone-controlled squelch system (CTCSS), tone sequential and dual-tone, multiple frequency (DTMF) signaling.

CTCSS signaling can be appropriate if only limited call address information is required, as is the case with interconnection to group-based LTR systems. The advantage of CTCSS is that it usually is already available in the mobile fleet, so any additional costs are minimal.

Five-tone sequential signaling is popular in many countries, but it is relatively inflexible. Although the crossband system is configured to use it, tone sequential

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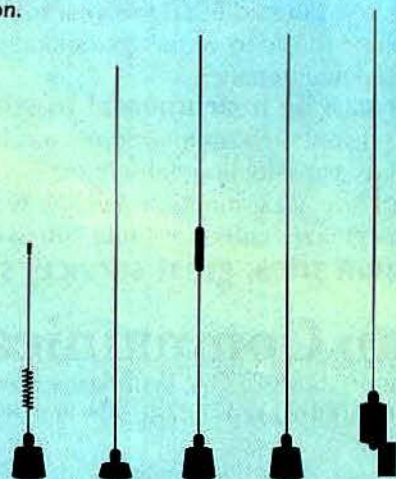
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signaling generally is not as cost-effective as CTCSS or DTMF.

The DTMF system has a number of key advantages: It works well; practically any brand of mobile unit supports DTMF, often as a standard "built in" feature, and in all cases, DTMF is readily available at low cost. Most importantly, DTMF offers "free-format" dialing, supporting any numbering system from single-digit messages to 16+ digit messages, as required for international PSTN access.

Most trunked radios also support "overlay" DTMF signaling, such that once the trunked call is set up and the radio is on a traffic channel, the user can key in DTMF messages of any format that can be used for signaling into the alternate direction. An example would be to call from an MPT1327 system into an LTR system or into an alternative MPT1327 system.

For these reasons, DTMF signaling has been adopted as the standard signaling method for the crossband system.

Important tasks for the crossband system are the overall call setup and maintenance functions, which are provided by a programmable micro-processor-based management system.

Two RS-232 serial ports provide communication with either the conventional or trunked side of the radio system. Communication with the trunked radio is either based on a proprietary protocol for specific types of radios or, in the case of MPT1327 systems, the universal MAP27 standard communication protocol is used.

Finally, the system includes all necessary audio processing functions such as level control and impedance matching.

A vital design achievement is that changes to the mobile fleet are minimal, if they are required at all. The crossband system generally is compatible with practically any standard conventional or trunked radio, existing or new—an essential capability to keep the interconnection process practical and economically viable.

Basic operation

In view of the crossband system's extensive flexibility, there is no single operating mode. To illustrate the basic system operation, though, we will describe a scenario wherein an existing conventional single-channel private

mobile radio repeater system is linked to a newly established MPT1327 wide-area trunked network.

It is assumed that a company's conventional radios communicate with each other and a base control point via a repeater that provides satisfactory and adequate service. The company wants to expand its activities with a new operating division that requires substantial additional coverage unavailable from the current repeater, but readily provided by a trunked system in the area.

Although the new division normally communicates only with its own units, sometimes it has to communicate with units in the original fleet. Converting entirely to use the new trunked network would solve the problem, but such a conversion is not economically practical,

nor is it really necessary, because the conventional repeater serves the existing operations satisfactorily.

A crossband system installed at the repeater and connected to a fixed trunked radio for trunked network access links the two systems together as and when operation-

ally required.

The conventional repeater system continues to operate normally and so does the new trunked fleet on the trunked repeaters.

When a user on the conventional system calls a trunked radio, Fleet Number 256, for example, the operator transmits a DTMF sequence: 2-5-6-#. The crossband system recognizes the interconnect request to trunked mobile No. 256. The serial communications link between the crossband system and the fixed trunked radio at the repeater causes the trunked radio to set up a call to unit 256. At the same time, the crossband system keys the repeater. Call-progress tones and other advisory messages generated by the trunked radio are now heard by the conventional mobiles, including messages such as "ringing," "busy" and "not available."

In other words, the conventional radio "behaves" as though it were a trunked radio. The remote trunked subscriber receives the call as if it were made by a trunked radio.

The system operates similarly in the reverse direction. When a trunked

*... the conventional
radio "behaves" as
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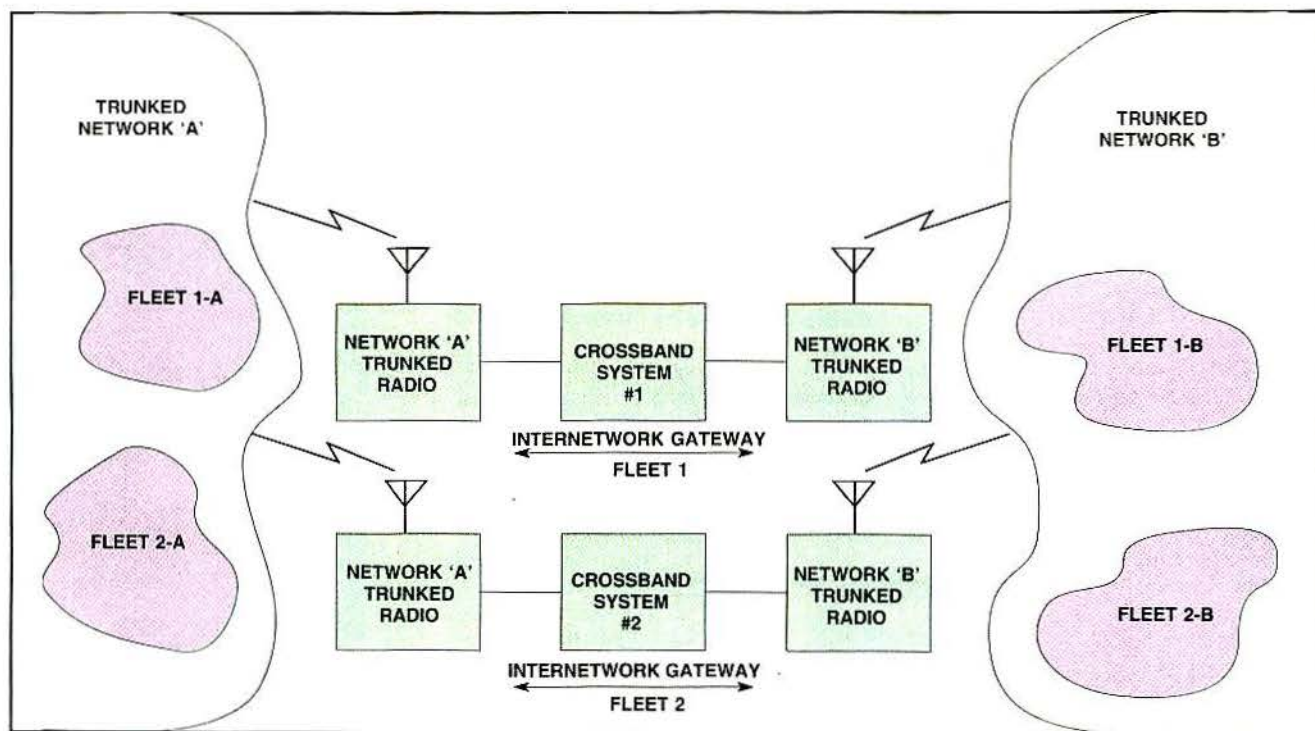


Figure 3. Two trunked systems are linked using overlay DTMF signaling for intersystem dialing. Such a link may be established where two carriers operate adjacent or overlapping trunked systems that need intercon-

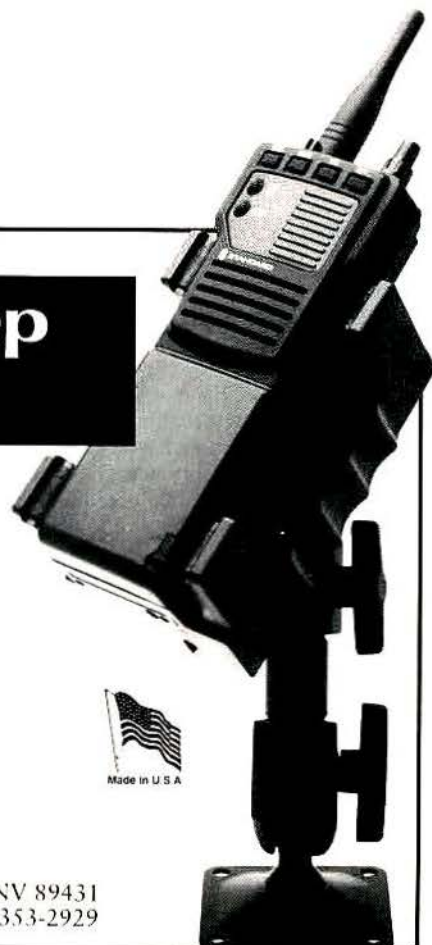
nection to provide continuous coverage for roaming mobiles and/or where direct control center interconnection is not possible or practical.

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subscriber calls a conventional unit, he calls the crossband system's trunked radio address, which switches the call through to the conventional repeater. The trunked system radio then functions as an extension of the original conventional network until the call is cleared, either by the trunked system caller or by the conventional unit operator, by sending a *# trunked call termination command.

Except for a DTMF encode capability (a

standard option on many types of radio and in all cases a readily available low-cost option), no changes are required to existing conventional radios, and the new trunked radios are completely standard units.

Applications

The ability to connect various systems opens up a wide range of operational system implementations.

An obvious application is to provide a gradual migration path to a trunked system, allowing the customer to spread out the required investments over a longer period to avoid one large capital expenditure that may not be practical.

From an operational point of view, there are far more important applications.

The system may be used to extend existing trunked system coverage into areas that it cannot cover with trunked repeaters, perhaps for technical reasons. If for example, the trunked system operates at VHF, it might not penetrate a large shopping complex as reliably as a dedicated UHF repeater. Economic reasons may limit coverage. For instance, trunked coverage of certain rural areas may be too expensive. Trunked coverage into tunnels and other underground areas generally is impractical.

In a different application, the trunked system may be used to provide a "dial up" link among two or more conventional systems, using the trunked network's wide-area coverage as an "umbrella" for scattered local operations.

Finally, the new interconnect system may be used for back-to-back connection of trunked systems. Figure 2 on page 32 shows an existing LTR system interconnected with a newly established MPT1327 system. LTR radios use DTMF to dial various MPT1327 addresses, and MPT radio users dial the crossband system address for automatic connection with the LTR fleet on a group basis.

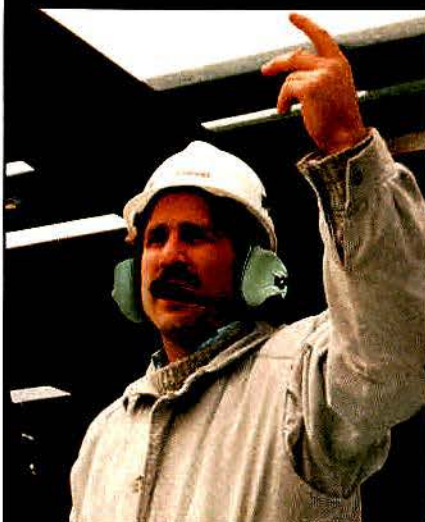
Figure 3 on page 36 shows an application in which two MPT1327 systems are linked using overlay DTMF signaling for intersystem dialing. Such a link may be established where two carriers operate adjacent or overlapping trunked systems that need interconnection to provide continuous coverage for roaming mobiles and where direct control center interconnection is not possible or practical.

Conclusion

Because of the universal concept of the new crossband system, it is practical to interconnect a wide range of conventional, analog and digital trunked systems without requiring "super mobiles" that are individually compatible with different trunked networks through which they communicate.

This flexibility opens up a wide range of applications that will enhance the application of mobile radio as an effective business communications tool.

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Mobile data for utility workers: Is it worth the investment?

It is time to bring field workers into the community of mainframe users by using a mobile radio network. Install a start-up mobile data system and shake out the bugs. The return on investment is worth the effort required.

By Tom Thorsen

In these times of cost-cutting by utilities, does the expense of providing direct computer access to the mobile worker really pay off?

It is the same old story; everybody who needs database access has it, except the employee who works outside the office. If he is lucky, he can persuade the dispatcher via voice radio to access the database for him. Then, of course, the dispatcher has to read it out loud, and the field worker has to write it down—quickly. If the information is technical, complicated or lengthy, good luck on getting it right the first time. Furthermore, when the worker is using

voice mobile radio, there are bound to be interruptions from other users on that frequency, plus the normal static and interference.

Now visualize the same field worker with a laptop personal computer (PC) in his vehicle. The laptop is plugged into a mobile radio data modem, which is plugged into the same mobile radio that previously was used for voice. Instead of trying to reach a dispatcher, the field worker signs on directly to the corporate database and looks up the required information himself. Not only is this process more convenient, it saves time, it is error-free, it bypasses the dispatcher bottleneck and the information is absolutely up to date.

How does mobile data pay back the corporate investment in hardware and software?

Employee expense

The largest cost to any business is the expense of supporting each employee. Besides salary and benefits, there are work space, tools, vehicle expense, liability insurance and worker's compensation. For every worker who is not required, there is a significant improvement at the corporate bottom line.

Consider one example: the daily routine of the connect/disconnect (CD) worker. Without mobile data, the worker gets a list each morning of customers to add or to delete from the power network. Because the list was prepared the day before, there is no way to know if any of the disconnect orders were paid since the list was printed. The worker does his job, based on yesterday's data, and hopes he does not have to reconnect too many of the disconnects. But of course, he does, and if he meets an irate homeowner, he has to try to verify the disconnect order by phone or by voice radio, adding 10 minutes or so to the call. The same worker with mobile data can check each customer's payment history before he disconnects service. Not only does he save a second trip to reconnect, but he keeps the customer happy, too.

Formal studies of the cost savings achieved using mobile data for CD alone show a 150% improvement in the number of work orders completed, a reduction in overtime to nearly zero and

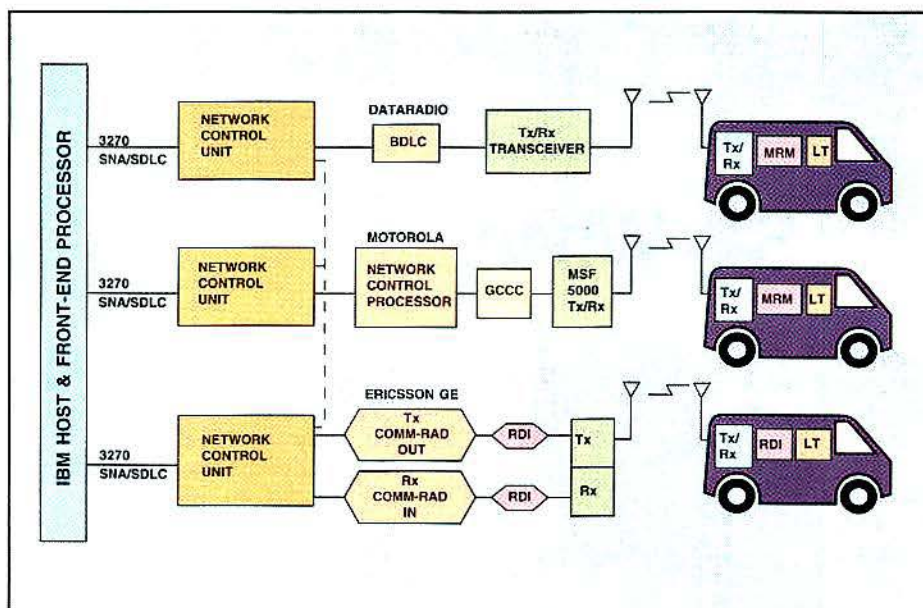


Figure 1. This diagram shows how the mobile data software has been used by Dataradio, Motorola and Ericsson GE in each company's network. The dotted line between the three network control units (NCUs) represents a feature called inter-base station control (IBSC) that allows users on the three networks to communicate peer-to-peer to receive the conference feature. Thus, the software brings each network into a common interface without regard to radio frequency, proprietary radio hardware, user location or the number of base stations on the network.

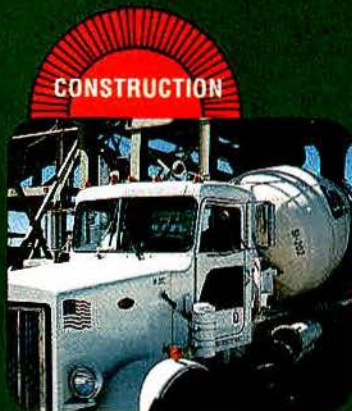
Thorsen is director of wide-area network products at LXE, Norcross, GA.

The Comm-Rad software referred to in the article is supplied by LXE.

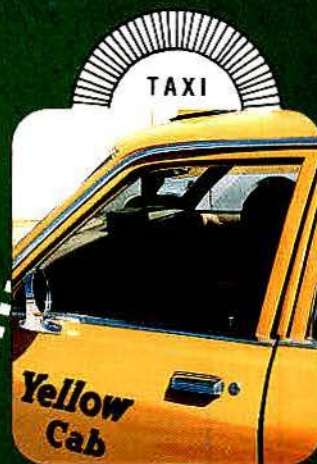
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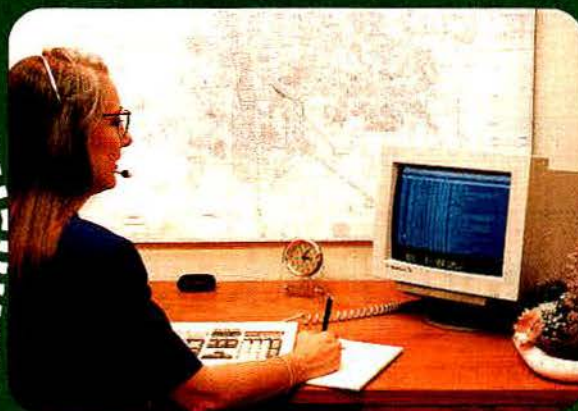
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customer satisfaction improved 100%. Thus, mobile data makes each field worker more productive, and that requires fewer workers. Also, the number of dispatchers and other administrative people can be reduced because there is less need for both voice and written communication. Finally, more users per frequency can be added to the radio network because data over radio is five to 10 times more efficient than voice over radio.

Bottom line: Mobile data improves every field worker's productivity and gives that worker more control over job-related information, improving the worker's morale and the customer's satisfaction.

Safety

In an emergency, voice radio traffic increases so rapidly that emergency crews can lose 15 minutes or more in trying to send a message to, or receive a message

from, the dispatcher. When the emergency crews switched to mobile data, the 15-minute delay became a 15-second data exchange with no errors and no need to ask the dispatcher to "say again."

Using mobile data for rapid response to damage reports can save lives. When a vehicle hits a power pole, or when a storm sweeps through a community, downed power lines, fires and other disasters require prompt access to shut off utilities to certain locations. By rapidly accessing the power grid database via mobile data, the emergency crew knows exactly where to start the emergency routine. Direct access via mobile data communications allows the crew to identify and to order replacement parts quickly via the corporate mainframe. This reduces downtime and puts

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*Mobile data improves
every field worker's
productivity and gives
that worker more control
over job-related
information . . .*

paying customers back on line sooner.

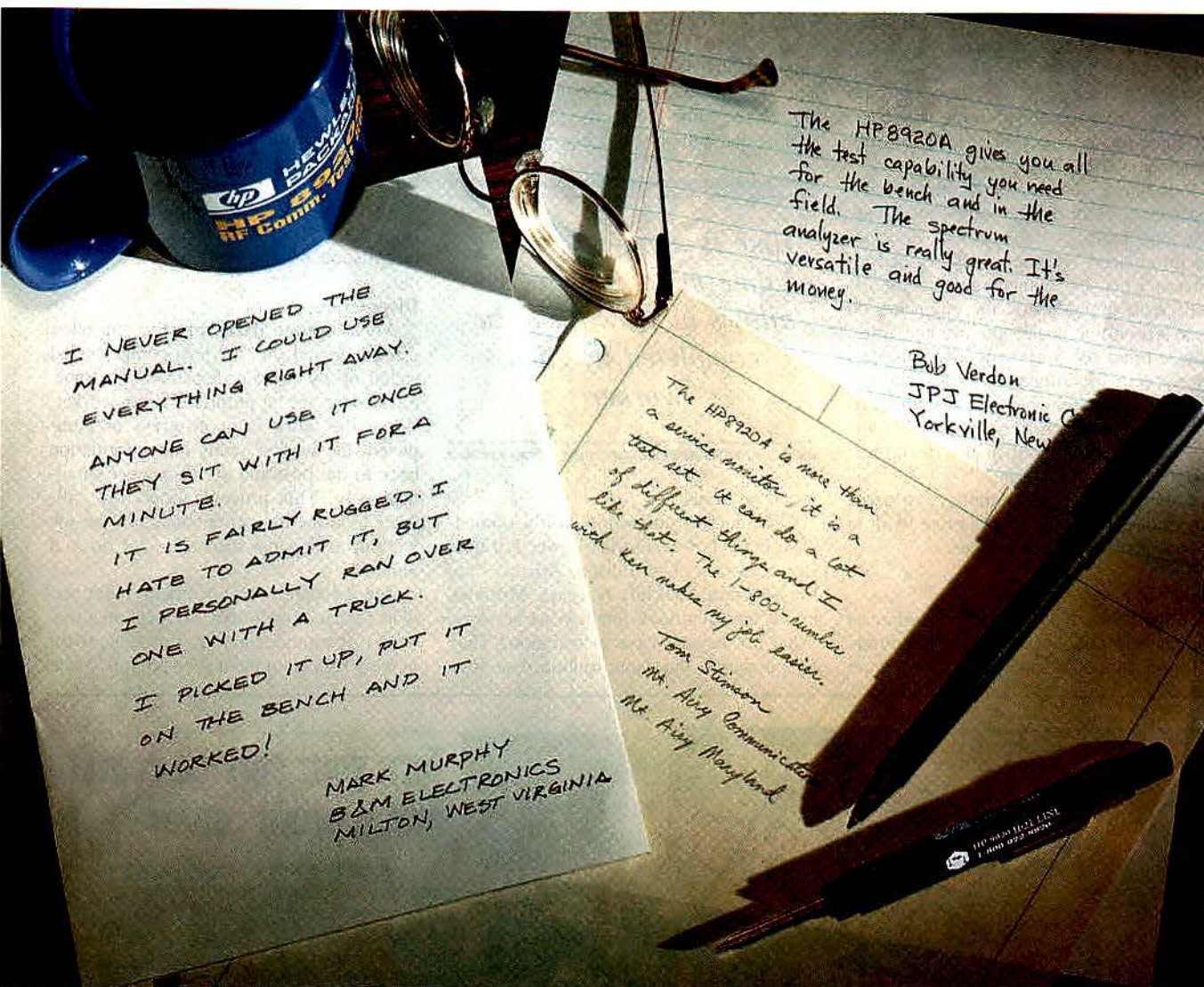
In studies made by several utility companies, prompt response to damage reports and customer complaints has not only put the users back in service sooner (which means more revenue), it demonstrated the utility's commitment to the safety and welfare of its customers.

Bottom line: Safety and response time go hand-in-hand. Mobile data provides fast, accurate information to the work crew, reducing the threat of injury or loss of life to workers and customers alike.

Real time vs. lost time

Suppose your job as a field service representative requires you to investigate a possible current diversion. If you are on-line via mobile data to the corporate database, you can easily match the meter number to the address, determine whether the meter is stolen, check to see whether the account is active, and look at the history of the customer to see whether he has a profile of current diversion activity. Checking this information on-site via mobile data provides immediate proof of theft of power and sufficient reason to disconnect the offender immediately. Without mobile data, it could be the next day before the current diversion is verified, and by then it already

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may be restored to its normal condition.

In another scenario, a storm causes a power outage in a localized area, creating more work than the crew in that area can handle alone. Via mobile data, crews with little or no emergency work can sign onto the work order log and take the jobs nearest to them, completing the restoration sooner and more safely.

In another example, the engineering department goes on a site survey for a new shopping mall. Without mobile data, all the information is gathered off-line and re-entered when the team returns to the office. With mobile data, the engineers do their job on-line at the job site and finish in real time. All it takes is a mobile data interface in the engineering van, and the site team efficiency improves immediately. No new errors are created when the site work is re-entered in the mainframe hours later.

Bottom line: Time is money, so using time more effectively allows more work to be completed by each worker.

Hardware and software

In the utility industry, IBM mainframes and mobile radio networks are common. Millions of dollars are spent every year

keeping these vital resources up to date and 99.9% available at all times. But, as with oil and water, mixing these two resources takes a lot of "stirring" by some authority that wants to see it really happen. Because these two groups rarely report to the same company vice president, finding that authority is a big problem, but

*Time is money, so using
time more effectively
allows more work to be
completed by each
worker.*

it can be done.

Consider the following utility companies: Duke Power, Florida Power & Light, Union Electric, Con Edison, Arizona Public Service, Sasktel, Niagara Mohawk Power and Central & South West Services. What do they all have in common? They all purchased the same mobile data soft-

ware solution, Comm-Rad.

The software solution is designed to deliver IBM SNA/SDLC data to a laptop PC in a vehicle via mobile radio. This means that the data on a PC in the office can be displayed on a PC in a vehicle. No changes to the IBM applications are required to transmit them via mobile radio. Information accessed via CICS, IMS and TSO is available from the vehicle.

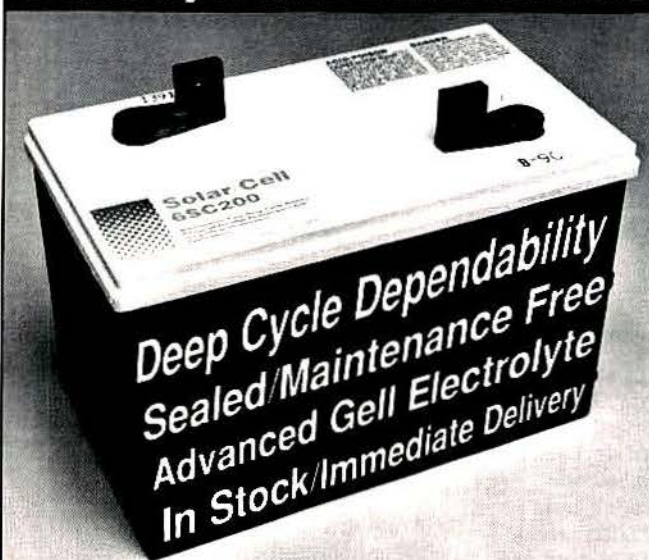
The user can select certain fields of data from the 3270 screen, leaving unnecessary information off the field worker's screen.

Dispatching

As an option, data from the call-taker can be entered into the host computer and called up by a radio dispatcher for transmission to the appropriate field worker. When the work is in progress or completed, the worker sends that information back to the host and the dispatcher simultaneously. This process allows the call-taker to know the current status of the job without asking the dispatcher for an oral update.

The software does for mobile radio networks what Novell does for local area networks: It provides a software solution for moving data from point A to point B. More

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than that, as with Novell, the software provides information to the user about who is on the network, diagnostic information for troubleshooting, and reliable delivery of error-free data to the user.

There are no industry standards for mobile data communications. Each manufacturer of radio modems uses a proprietary protocol, and each network has its own scheme for delivering information to the user. So far, the software has been used

successfully by three radio modem manufacturers: Dataradio, Motorola and Ericsson GE. A block diagram of how the software is installed with each of these networks is shown in Figure 1 on page 40.

The dotted line between the three network control units (NCUs) represents a feature called inter-base station control (IBSC) that allows users on the three networks to communicate peer-to-peer to receive the conference feature. Thus, the

software brings each network into a common interface without regard to radio frequency, proprietary radio hardware, user location or the number of base stations on the network.

Of course, it all comes down to money. Improving efficiency, safety and customer support saves money, but building a radio data communications network costs money. With the right software, getting started does not require a large investment.

Typically, a new software user begins with a 10- to 25-vehicle system. The software portion costs less than \$100,000, and each vehicle installation adds another \$3,500, assuming the existing voice radio is adopted for data communication use. This brings the hardware and software start-up cost for a 25-user system on line for less than \$200,000. Because no IBM applications need to be modified or written especially for the conversion, there is no significant management information system (MIS) expense. Training takes five days.

User attitude

How does the average utility field worker adapt to doing his job with a computer? With enthusiasm!

The notion that "big guys with dirty hands" would not even touch the PC keyboard has been completely dispelled by experience. The terminal software is designed for easy use by inexperienced users. This is done through scripting, a feature that allows each utility to create easy-to-use keystroke patterns to accomplish complex responses and inquiries.

Another feature will be added to allow Windows software to operate in the remote terminal. This feature will further simplify use by the field worker. In every case, even the most reluctant worker has discovered that the use of a mobile data terminal makes his job easier and gives him more control over getting his job completed in a safe and timely fashion.

Summary

Mobile data is the last frontier in the world of data communications. Every utility company in America has a huge database that usually resides on an IBM mainframe. Enormous progress is made every year in making that database more available to all the workers who need it, as long as they are connected via wireline. It is time to bring the rest of the workers, the ones in the field, into the community of mainframe users. There are proven solutions to the delivery of mainframe data over the mobile radio network. Now is the time to install a start-up mobile data system and shake out the bugs. The return on investment is worth the effort.



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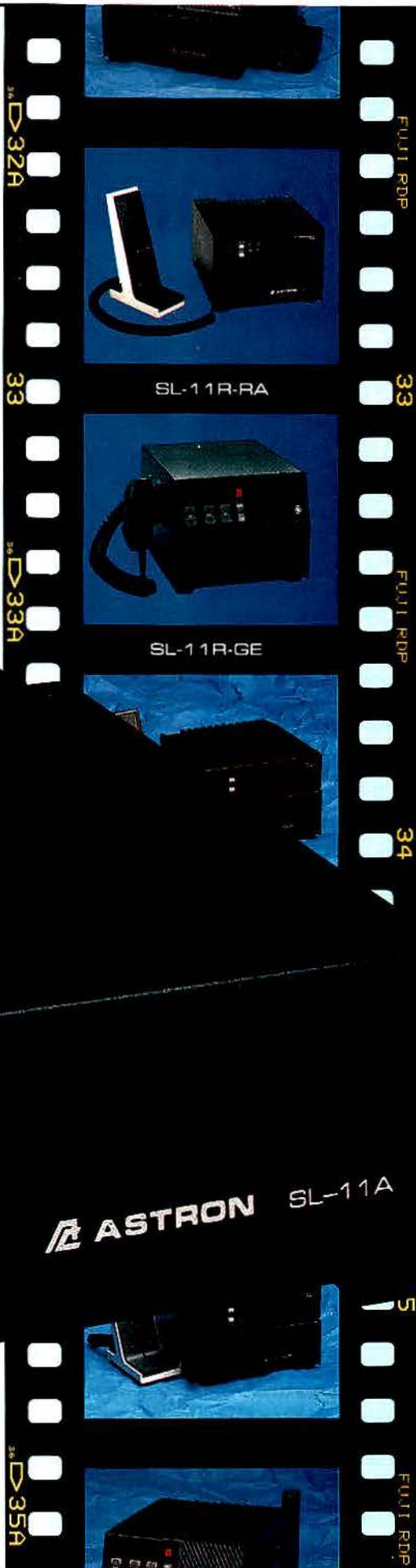
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Martin County Sheriff's Office picks mobile computing system

More stolen cars are being recovered, more wanted persons are being arrested and officer safety has been enhanced with the use of mobile computers. A suitable RF modem and network controller are key components.

By William Sprague

Reduced budgets and staffing problems are requiring law enforcement agencies worldwide to re-evaluate how they perform their duties. Many departments are investigating how high technology can help them to cope with a growing workload. One technology being examined is the computer—not just desktop computers, but mobile computing systems that streamline operations, cut report-writing time, reduce paper-handling and increase overall efficiency. (See Photo 1 to the right.)

In the summer of 1991, the Martin County Sheriff's Office, Stuart, FL, began to research mobile data terminal (MDT) and mobile computer terminal (MCT) technologies. MDTs have been in use for many years. Most police departments are familiar with one or more of the available MDT variations and their limitations. On the other hand, MCTs are a rather recent development. The MCT is a combination of a radio frequency or cellular telephone modem and a computer.

Although MDT technology is well-established, it has not evolved much since its introduction. The available MDTs have limited capabilities, and it is difficult to alter their programming. In contrast, the MCT can be a state-of-the-art 486 note-

book or an economical 286 or 386 desktop computer. These computers have enormous storage advantages compared to MDTs, not to mention increased power and

communications device, the MCT commonly is connected to larger computer systems. Connections are made using standard electronic protocols and solid wires, telephone

lines or microwave radio links. The MCT itself operates a communication program that allows it to communicate with the host computer. (See Photo 2 on page 50.)

To operate effectively in a motor vehicle, a device must be installed to allow a radio channel to be used as the data communications transmission medium. Although radio interfaces have been available for nearly 20 years, it has been difficult to configure a system to allow 30 or more vehicles to share a single radio channel without mixing data intended for one vehicle with data intended for another. Various methods have been used to solve similar computer network problems. For the radio interface to communicate properly, the integration of several of these methods

was required. (See Photo 3 on page 51.)

► **Report-writing and data collection** — The mobile computing system should help patrol officers and investigators to prepare

Sprague is a sergeant with the Martin County Sheriff's Office, Stuart, FL. Metroplex Mobile Data, Fort Lauderdale, FL, supplied the mobile computing system described in this article.

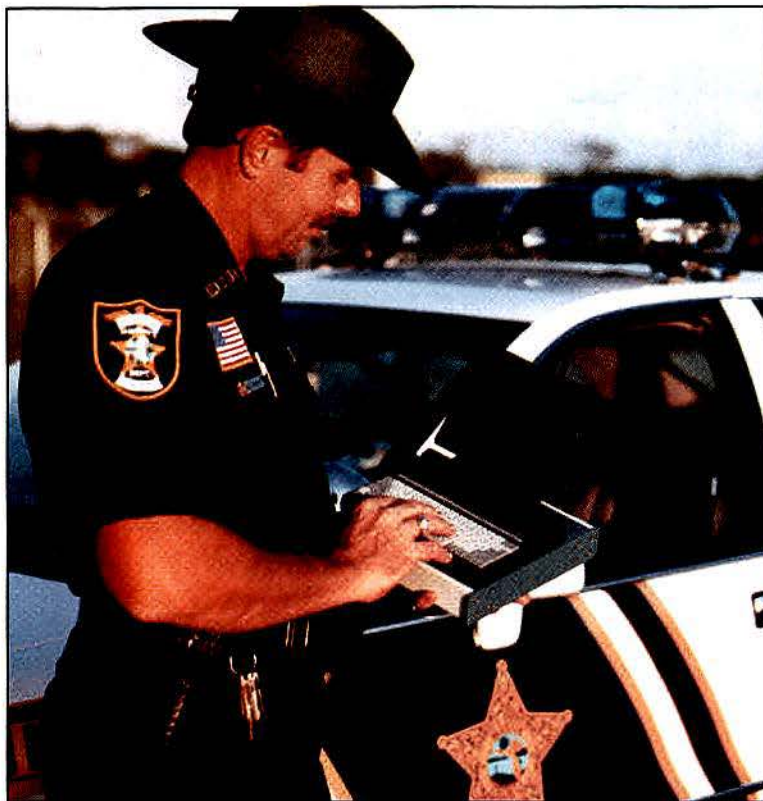


Photo 1. Mobile computing systems streamline operations, cut report-writing time, reduce paper-handling and increase overall efficiency.

access to literally thousands of off-the-shelf software packages.

Laptop applications

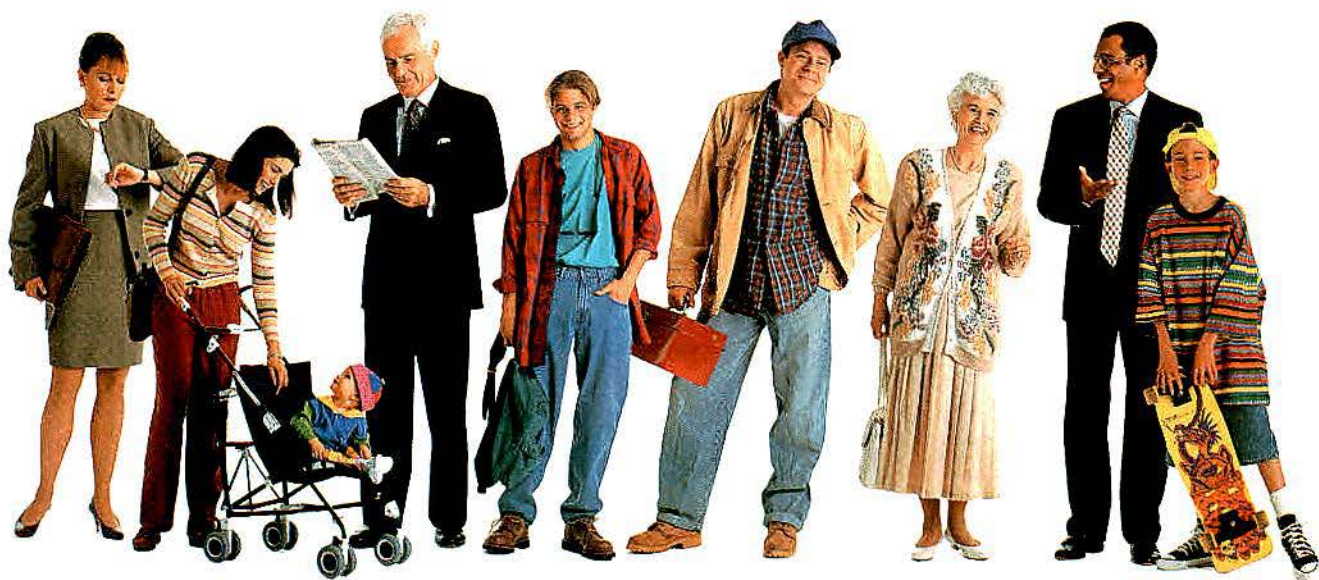
The Sheriff's Office wanted to use the MCT for three basic functions: for communications, for report-writing and data collection and for storing information.

► **Communications** — As a communi-

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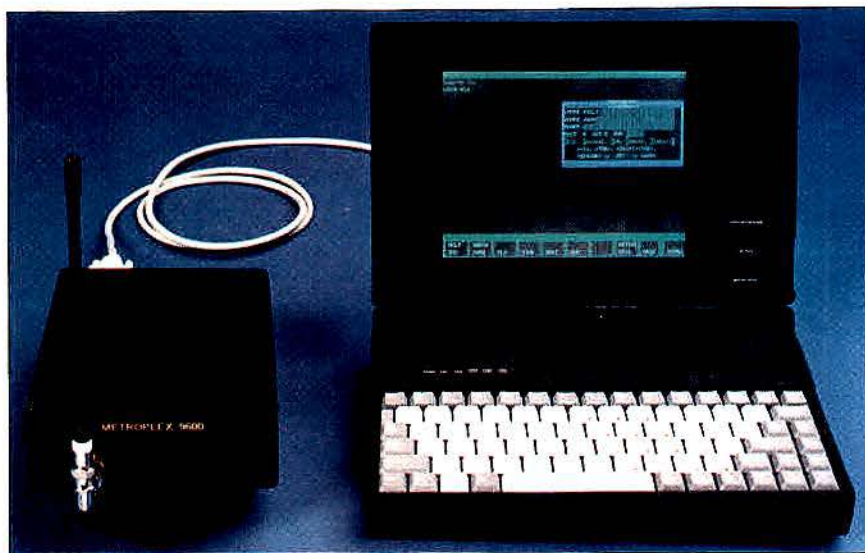


Photo 2. The mobile communications terminal includes an RF modem (left) and a color computer. The computer operates a communication program that allows it to communicate with the host computer. The RF modem is capable of a maximum data rate in excess of 18,500-bit packets per second.

reports. It should be able to capture data directly from an officer's report, eliminating the need for clerks to read every report and to retrieve statistics required by the state and federal governments and by the

Sheriff's office's own records management system.

Once data are collected in the field, they can be routed to multiple databases without human intervention. A survey con-

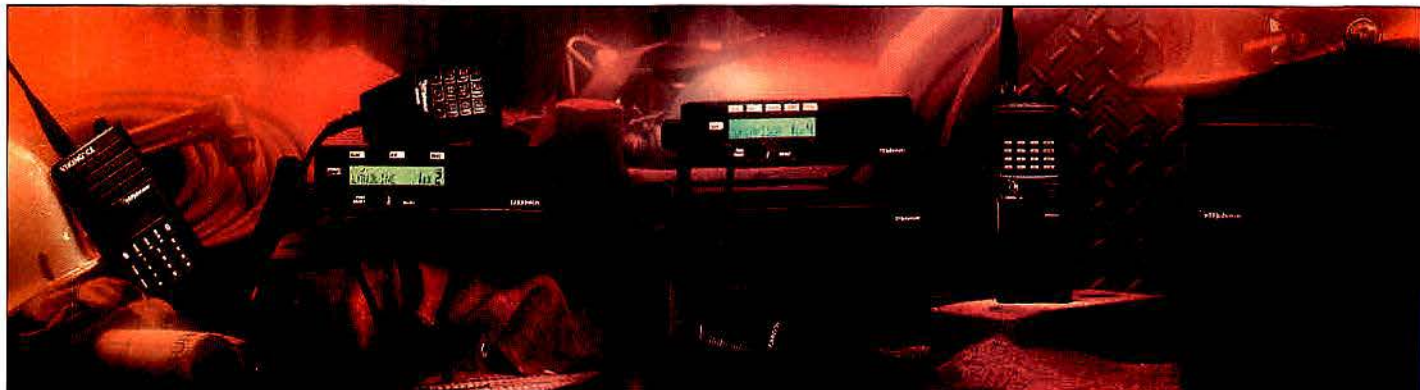
firmed that the use of notebook-size portable computers allows better police reports to be prepared in less time and to the greater satisfaction of the police officers. (See Photo 4 on page 52.)

► **Information storage** — The mobile computing system should store electronic reference libraries for use in the field. Modern police officers must have a variety of information close-at-hand. The department maintains hundreds of volumes of information that obviously cannot be transported in printed form by patrol officers when they go into the field.

Examples of useful information include details about hazardous materials, the computer-aided management of emergency operations (CAMEO), charge and statute information and the Sheriff's Office's standard operating procedure. Without such information in the field, the officer may be forced either to act without it, to drive to the police station to use reference books or to call for assistance. Standard computer software can be used to produce electronic forms for most of this type of information. Each MCT can carry the information, giving patrol officers wider access to it.

Above all else, some mechanism

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must allow the officer to use the report-writing features and to remain in constant communication with the dispatchers. In our case, we also wanted the MCT system to be compatible with our existing computer-aided dispatch (CAD) and radio systems.

Wish list

Based on our research, we listed what we had learned and the goals that we wanted to accomplish both immediately and over five or 10 years as functions that are unavailable today become available.

This "wish list" includes:

- ☐ laptop or notebook computers in the vehicles.
- ☐ optional printer support.
- ☐ radio modems (as opposed to cellular).
- ☐ car-to-car communications.
- ☐ multi-car conferencing.
- ☐ access to FCIC/NCIC.
- ☐ the ability to integrate into our existing records management system.
- ☐ E-mail.
- ☐ compatibility with automatic vehicle location (AVL) or Global Positioning System (GPS) systems.
- ☐ compatibility with NCIC-2000.

After evaluating many vendors, viewing presentations, talking with representatives of other police departments with MCT systems and visiting MCT installations across the United States, we wrote a Request For Proposal (RFP) that met our requirements. More than 50 RFPs were mailed, and a vendor with an RF modem that works on any frequency was selected. The vendor can supply a complete system using existing laptop computers. We chose a mixture. The vendor provided a turnkey system with 10 specialized MCTs, and we provided 15 other laptop computers from various manufacturers.

Officers from the 12-unit traffic division and the warrant division, along with other officers from throughout the Sheriff's Office, were chosen to receive the first 25 units. We provided units to our in-house personal computer (PC) experts as well as to novice computer users. In December 1992, the system became operational.

Changes in the mobile computer software were made to accommodate the Martin County Sheriff's Office operation. Several new inquiries were added to the FCIC/NCIC portion of the mobile soft-

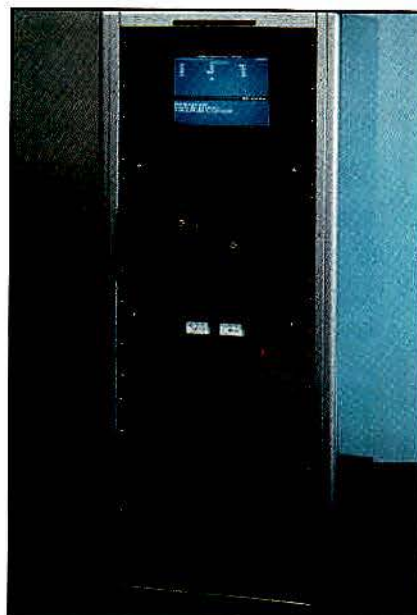


Photo 3. A computer-based wireless network controller supports a maximum of 2,048 simultaneous field connections between mobile computer terminals and hard-wire circuits to host computers, consoles and telephone lines. It handles all unit-to-unit and unit-to-base communications and tracks the source of each RF connection.

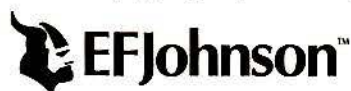
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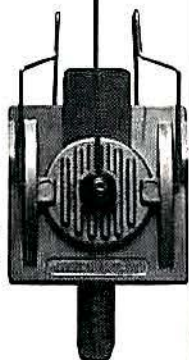
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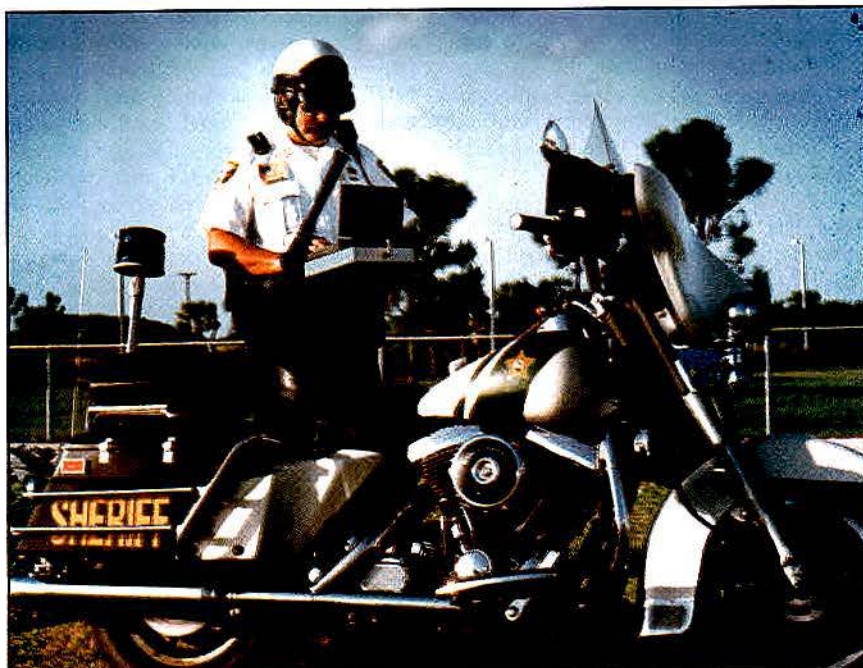


Photo 4. Notebook-size portable computers allow better police reports to be prepared in less time and to the greater satisfaction of the police officers.

ware. A search system for the Sheriff's Office and jail records was integrated. Road patrol supervisors requested a unit "call status" screen that is updated on a regular basis. The vendor took officers' "what if?" questions and turned them into realities.

Even though the MCT system has been in operation only 18 months, its advantages are becoming apparent. More stolen cars are being recovered, more wanted persons are being arrested and officer safety is being improved. It is no longer necessary for an officer to wait for communications because 10, 12, or more units already are in queue. FCIC responses appear in seconds instead of minutes. The status of license plates on 10, 20 or even 30 vehicles in shopping centers and hotel parking lots can be processed by MCT without overburdening a dispatcher. Because data communications cannot be monitored by eavesdroppers, the scanner-wielding felon will not even know you are on to him.

The system has a full-duplex, digital frame-regenerating repeater mounted where it gives superior coverage of Martin County that extends into surrounding counties. Each patrol car has an RF modem in the trunk, cabled to a 386 notebook computer. The computer's special mount allows it to be used just as easily by the driver or passenger. The mount is a double-knuckle style, similar to a dentist's tool tray. A mount is available for 1994 model cars with dual air bags. A

portable unit developed by the vendor for our use includes a subnotebook-size computer with an attached RF deck. Preparations are under way to test the portable units in a marine installation.

The second phase of the MCT installation is in its final stage, which involves connecting with a records management system (RMS). The mobile computers will display predefined fill-in-the-blank viewscreens for our existing reports. Because the MCT system is based on a "smart" computer instead of a "dumb" terminal, all screens and formats are stored on the computer's integral harddrive. With notebook computer hard drive capacity extending to 100 megabytes and beyond, the number of formats that can be stored and made available in the field is almost unlimited. This capacity will greatly reduce the air time required for records transactions because it is unnecessary to download forms.

This second step of our "leap into technology" will greatly reduce the paper flow around the office. In addition, it will keep officer visibility in the community high, because officers no longer will have to return to the station to turn in reports or to use one of the desktop computers.

WJ

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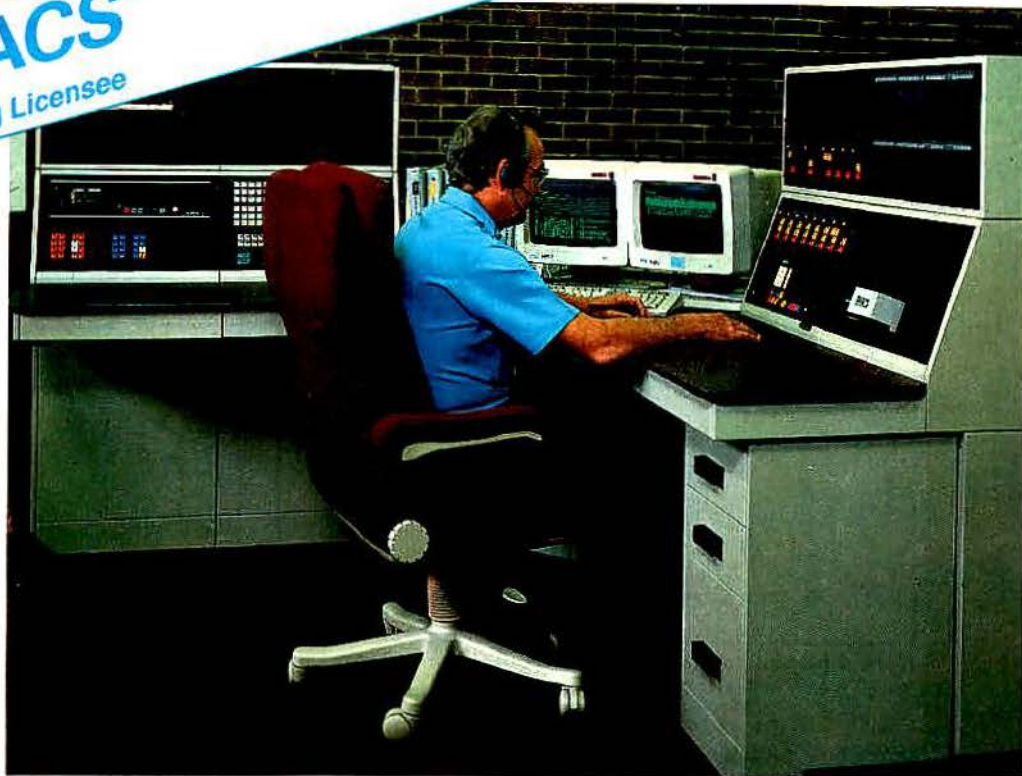


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Technically speaking

(continued from page 8)

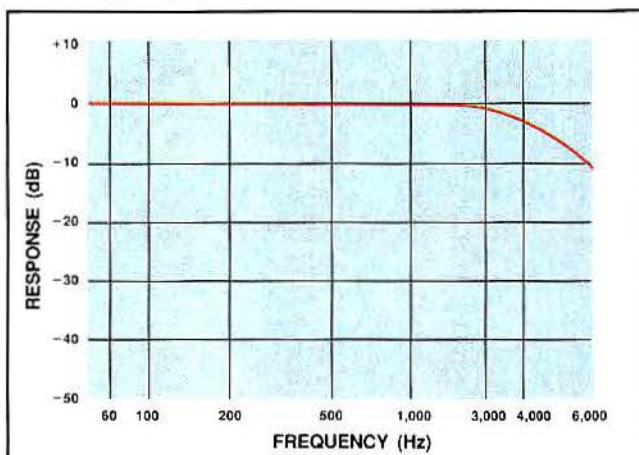


Figure 3. Response of a 3kHz flat filter. Courtesy Hewlett-Packard.

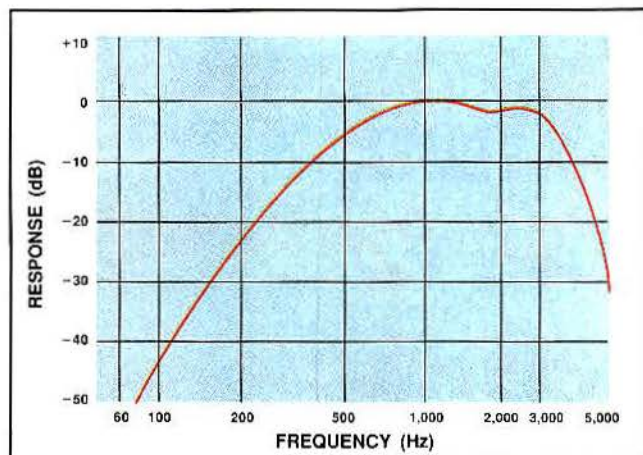


Figure 4. Response of a C-message weighting filter. Courtesy Hewlett-Packard.

► **Test setup** — Figure 2 on page 8 shows how the equipment is set up to run the noise measurement test on the telephone line. One end of the line is terminated in a 600Ω resistor (560Ω will do), and the TIMS is connected to the opposite end of the line. The TIMS can be set to measure in dBm or dBm as preferred by the user. A reading of 30dBm or -60dBm

would be acceptable. Higher noise levels may be tolerated by many systems.

► **Filtering** — When making noise measurements, it is important to use the proper filter. If you look closely at the middle of the transmission test set control panel in Photo 1, you will note that several different filters are available. Because we are dealing with voice frequency communica-

tion circuits, the filters of interest to us are the 3kHz flat and the C-message filters.

The response of the 3kHz flat filter is shown in Figure 3 above left. The response of the C-message weighted filter is shown in Figure 4 above right. The C-message filter is designed to pass the audio frequencies that contribute most to the intelligibility of the speech signal. The C-message

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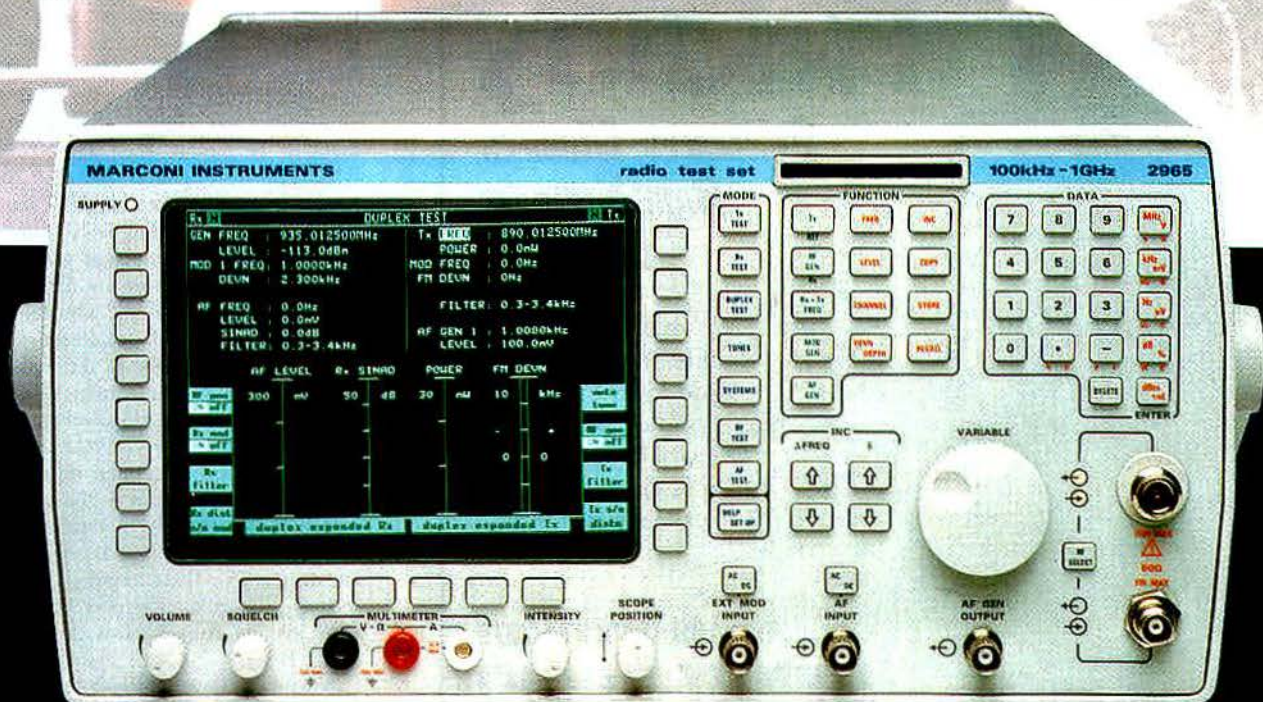
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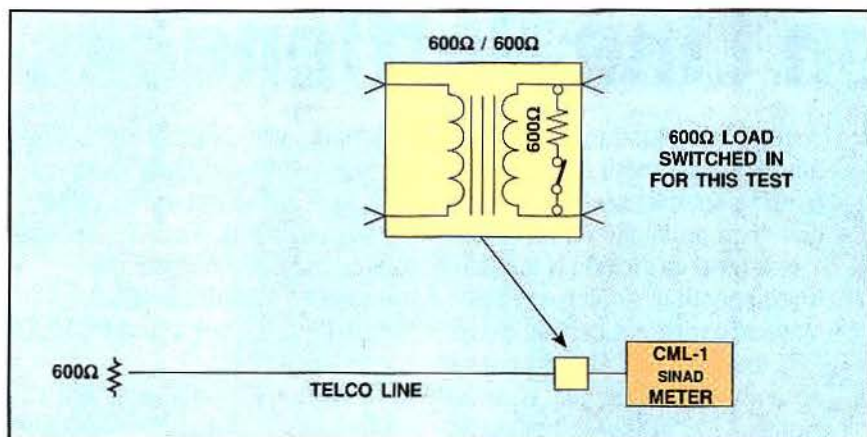


Figure 5. Setup for measuring telco line noise using the Helper Instruments model CML-1 SINAD meter. Because this instrument does not have a balanced input, the line transformer shown in the inset is inserted between the line and the instrument to prevent unbalancing the line. Because the instrument has a high input impedance, the 600Ω load resistor is switched in for this measurement.

filter sharply attenuates out-of-band frequencies because noise outside the normal passband is not considered to be detrimental to communications. Note that a 60Hz hum would be prominent in the passband of the 3kHz flat filter, but it would be attenuated by more than 50dB by the C-message filter.

► **CML-1 SINAD meter** — The CML-1

SINAD meter is shown in Photo 2 above right. It can make measurements to -60dBm, and it has a C-message filter that can be switched in or out as needed. These features make it suitable for making measurements on voice frequency communication circuits. This instrument also provides a 1kHz tone generator through a balanced (transformer-isolated) output.



Photo 2. Model CML-1 SINAD meter has a built-in C-message filter that can be switched in or out as desired. It also provides a balanced (transformer-isolated) 1kHz tone output that can be used for testing telco lines. It has a high-impedance unbalanced input that must be used with a line transformer and a 600Ω load. Courtesy Helper Instruments.

The BNC connector (tone output port) is isolated from ground or chassis.


Noise can be measured with this SINAD meter in a manner similar to that described above for the TIMS, except that the measuring unit will be dBm. Figure 5 above left shows how to use the CML-1 SINAD meter to make line measurements. Note that a 600Ω/600Ω isolation transformer must be used between the CML-1 and the telephone line because the CML-1 does not have a balanced input.

These isolation transformers often are needed when making line measurements. Any connection to the telephone line always should be made through a line transformer to avoid unbalancing the line and causing measurement errors. It is worthwhile to mount such a transformer inside a small construction box with input-output connectors for convenience in hooking these in the circuit when needed. I prefer BNC connectors and five-way binding posts for more convenience. If you use a metal box, isolate the BNC connectors from ground with insulated washers. If a plastic box is used to mount the BNC connectors, isolation is not a problem. For added convenience, I installed a terminating resistor on one side of the transformer.

A high-quality transformer should have minimal insertion loss. However, it should be tested, and if the insertion loss is significant, it can be factored into any measurements made with it in the circuit. The insertion loss may be determined as follows: Switch the termination resistor in, and feed a 1V, 1kHz tone into port A and measure the voltage at port B. The insertion loss is found from the equation: $20\log(B/A)$.

Next month, we will take a look at more telephone line performance measurement techniques. *Stay tuned!*





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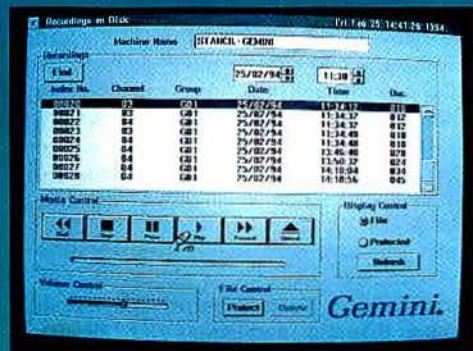


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Just shootin' the breeze on a Saturday night

By Robert H. Schwaninger Jr.

Last Saturday night, me and the boys were sitting around the table that Sam set up in the hardware store about 10 years ago when the barber shop became a saloon. Charlie the barber sold out to a chain

of stores that specializes in blow drying, leaving the shaving and cutting to one's own devices. Since then, the bull sessions that used to liven up Charlie's barber shop have changed address to Sam's Hardware and Dry Goods.

I noticed that after 10 years of coffee stains, cigarette stubs and beer slop, the

table wasn't much to look at anymore. But then, our group looked more than a little time-worn as well, and we weren't expecting Dorothy Parker to show up. It was just another evening of separation from our wives, who had wisely retreated to enjoy the nasal calls of "B-10" and "I-54" at the V.F.W.'s Saturday Night Bingo-rama. More marriages have been kept solid that way.

Anyway, the conversation turned to high finance and stratospheric technological confabulations. I've got to admit that I may be just plain too simple to appreciate it all, so I'll just tell it, and maybe you can make some sense out of it.

It started innocently enough when Jack asked Elmo how his boy, Little Elmo, was doing. We hadn't seen much of Little Elmo since he graduated from college and moved East, so to be polite and out of curiosity and since we knew nearly everything about everybody in town, Jack asked about Elmo's offspring.

"He's doing fine," Elmo reported. "He's got a job with that outfit, Nextel, that you read about in the paper. Yep, that company's going places, and Li'l Elmo's going right with it."

"You don't say?" asked Jack. "I heard that Nextel's buying up everything in sight these days. Saw an article in the paper said they bought another outfit called OneComm and then turned around and bought another one called Dial Page and then, dang if they didn't turn around and make a big deal with Motorola."

"That's true as the Gospel," declared Elmo, beaming just a bit. "Li'l Elmo's with a comer in Nextel. They say that Nextel's going to be making billions of dollars in just a couple of years."

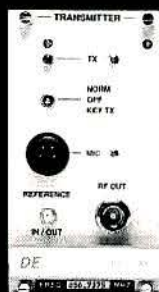
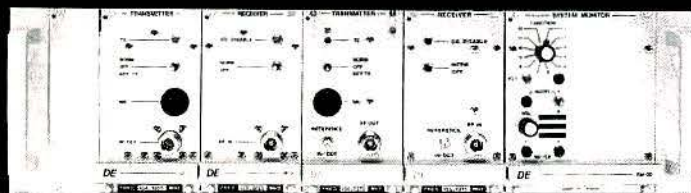
"How're they going to do it?" asked Josh, who had become more interested in the conversation than his scratching, but not ignoring the latter for the former.

Elmo frowned a deep frown that showed that his brain was about to be tried, and after giving his stubbled chin a deep rub, he began. "You see, there's these companies that have been selling dispatch radio service, like Joe uses to talk to his tow trucks. Now, Nextel's been buyin' up all these dispatch companies that all use nearly the same radio frequencies, and they're making a new, huge company out of them. Then they're going to make a new service out of all that radio spectrum

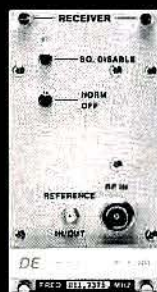
Schwaninger, *MRT's* regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

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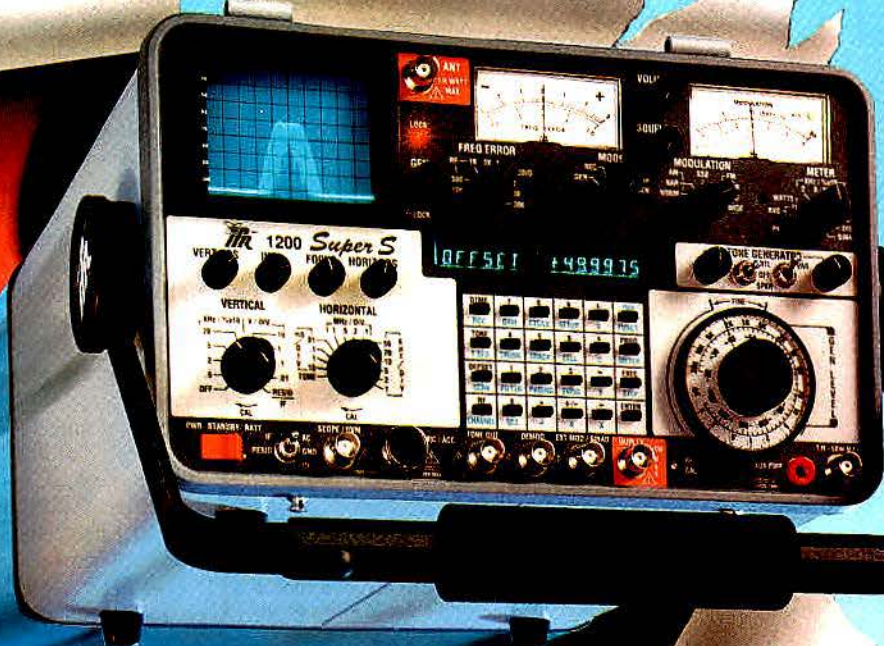
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that they call ESMR. It's supposed to be like cellular, only using what they call digital service, so that they can fit more people onto it."

"I read about that stuff in *Scientific America* or one of those magazines I get," offered Josh. We all turned to listen to Josh because he had been a radio man in Korea during the war and had developed

a keen interest in radios and tinkering and such. For more than 30 years, Josh was single-handedly responsible for keeping every radio, television, mixer, lawn mower and washing machine going in our part of the county. When it came to technology, Josh was our man.

"Exciting stuff," Josh reported. "Seems they can get six times the radio traffic on

frequencies with all those other outfits, then they won't be sharing radio channels with 'em, and then everybody gets to operate just fine."

"Who's going to pay for the swap?" asked Sam, suddenly stepping out from behind his counter, toting a box of shiny, new wing nuts.

"Why Nextel, of course!" said Elmo. "Shoot, that company's got money and stock and bonds and security and everything they need to finance the whole thing."

"Well, I'm not sure how I'd like that if I was one of those other radio fellas who was going to get their frequencies swapped," pondered Sam aloud. "It's like this. Say I sold these wing nuts to everybody in town. Perfectly good wing nuts, but then this big company comes along and wants to have an exclusive right to sell and use wing nuts. They even say that they'll trade out everybody's wing nuts to do the deal. How am I going to explain to my customers that they gotta give up their wing nuts? I know if I was them, I'd think that I had pulled a fast one and was probably only asking them because there was something wrong with the hardware. Nope, I wouldn't do it. Bad for business."

"Hey, Josh," piped in Jack, "what's the

Making airwaves



The FCC recently imposed a freeze on the filing of applications for new 800MHz stations, intending to review a Nextel proposal to concentrate ESMR use within the 860MHz band.

a single channel by using digital technology. The only thing that bothers me, though, is that I read that Nextel is going to use what's called wideband, sensitive digital receivers to listen for the customers' traffic. It seems that other radio operators, who haven't got a thing to do with Nextel's system, might cause them problems in getting the calls."

"What about that, Elmo?" I asked, not wanting to be a wallflower.

"Li'l Elmo tells me that that's all worked out. All Nextel does is get the government to allow it to swap

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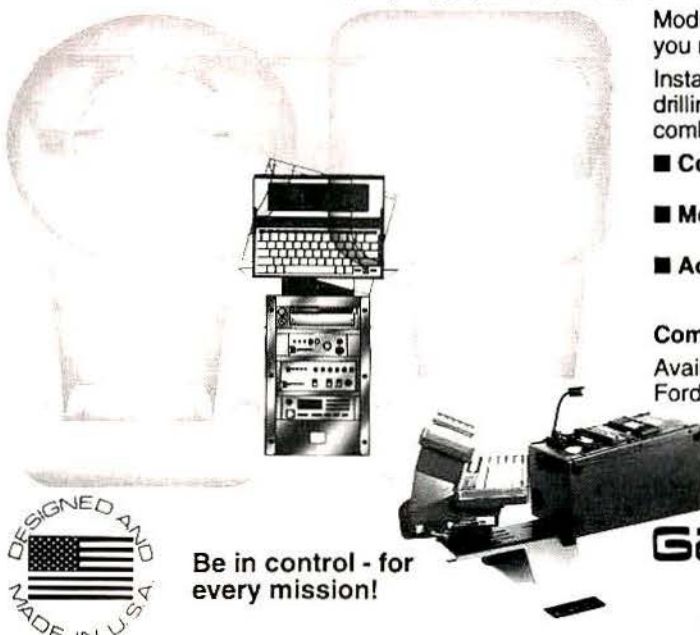
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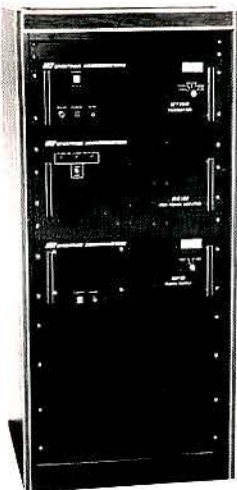
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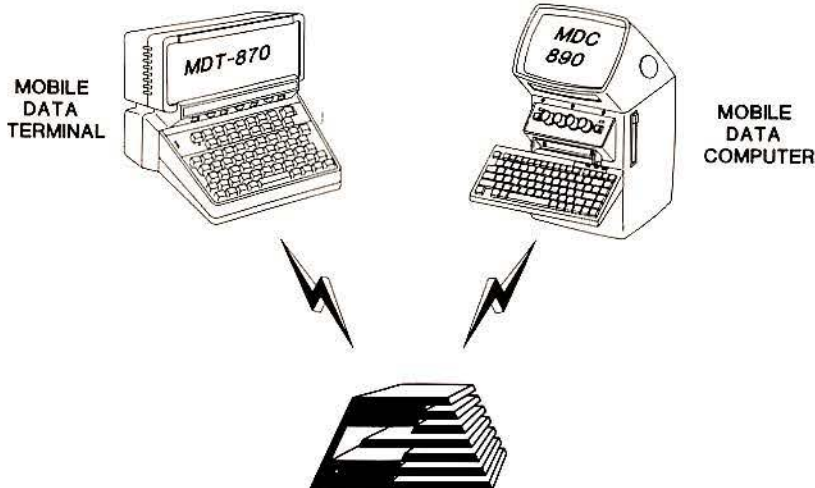
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Regulating technology

big deal about Nextel's radios anyway?"

"Well, according to what I see, there's not a big difference between them and cellular, except Nextel's going digital."

"That gonna cost much?"

"Yeah, it will cost plenty, but Nextel claims that people will pay for it."

"You think Joe will pay for one of those fancy services to talk to his tow trucks?" Jack asked.

"Nope. I asked Joe about whether he ever thought of putting cellular radios in his trucks, and he said that there was no way. He said that all he wanted was to be able to dispatch the trucks and didn't want any part of radios where the drivers could make personal phone calls."

"Well, I hope Nextel's not relying too much on guys like Joe," said Sam. "Seems that they might be doing something that nobody really wants or needs. Reminds me of a time that a salesman came to town to sell me some fancy screwdrivers that also could be used as a level. Now, I told that guy that there was maybe one guy in town silly enough to pay the price of one of his fancy screwdrivers"—(I turned away from Sam's sideways glance)—"and that most folks in this town just wouldn't pay for a bunch of stuff they didn't need or want at a price that was just too high."

"All this is just talk," declared Elmo. "It doesn't make any difference anyway."

"What do you mean?" asked Jack.

"Well, I think that Li'l Elmo's got it figured out anyway. You see, these radio channels that Nextel's trying to get all bunched together for their exclusive use lie right up alongside of cellular radio channels. So even if the whole thing's a bust, Nextel can just sell off the bunches of channels to cellular companies, and they could use them for their companies. Nextel'd make a bundle!"

"You mean if Nextel ain't got a service worth a hoot, that they can just sell the shootin' match to a cellular company and make out?" I asked.

"Sure. Easy as pie. Might not even have to change the cellular phones. Just put in a gizmo or two and, *ta-da*, you're talking on what were Nextel frequencies, using your cellular phone," said Elmo triumphantly.

"Say," said Sam, "that Little Elmo's pretty smart. What did he get his college degree in anyway, Elmo?"

"That's the strange part. Li'l Elmo got his degree in business administration, but it seems he's practicing medicine now for Nextel."

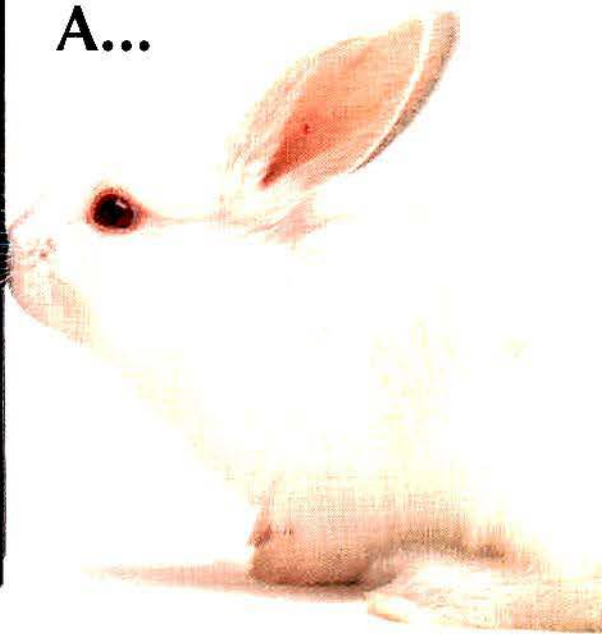
"What do you mean, Elmo?" asked Josh.

"Well, I don't understand it all," said Elmo curiously, "but he tells me he's a spin doctor."



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Nextel reaches agreements with Motorola, Dial page; agreement terminated among Nextel, MCI and Comcast

Nextel Communications, Rutherford, NJ, has reached agreements with Dial Page, Asheville, NC, and Motorola, Schaumburg, IL, valued at \$2.4 million. Nextel signed an agreement in principle for a tax-free merger transaction with Dial Page in which Dial Page's shareholders will receive about 28 million shares of Nextel or about 1.07 Nextel shares for each Dial Page share.

In a separate but related transaction, Nextel and Motorola have reached a definitive agreement for the sale of all of Motorola's SMR licenses and businesses across the United States for a total consideration of 62 million Nextel shares.

Nextel also has committed to a substantial purchase of Motorola Integrated Ra-

dio System (MIRS) infrastructure equipment over a five-year period. With previous orders for equipment, this order will provide sufficient infrastructure to build more than 4,000 cell sites in the United States, allowing for coverage of 85% of the U.S. population.

Nextel, MCI and Comcast have terminated their Feb. 28, 1994, letter of agreement. The three companies are continuing to explore the possibility of a strategic alliance to provide nationwide wireless communications, but on different terms. The companies said that no further details will be released while talks continue, and they said that no assurances could be given that a new agreement would be reached.

• In other Nextel news, the company

closed two key acquisitions that will allow it to extend the reach of its digital mobile service offering to San Diego, Las Vegas and other western markets. Nextel is currently offering its advanced wireless communications service in Southern California, San Francisco and the Sacramento Valley.

• Nextel has issued about 5.8 million shares to shareholders of Questar Telecom (QTI), formerly a subsidiary of Questar, and to a former subsidiary of Advanced MobileComm (AMI). Questar received 67% of the Nextel-issued shares, and AMI received the balance. QTI and Advanced MobileComm West are now wholly owned subsidiaries of Nextel.

Federal Express selects McCaw CDPD AirData service

Federal Express will become the first commercial customer of cellular digital packet data (CDPD) with its selection of AirData from McCaw Cellular, Kirkland, WA. Federal Express plans to use the service to augment its private 800MHz RF network by early fall this year in Las Ve-

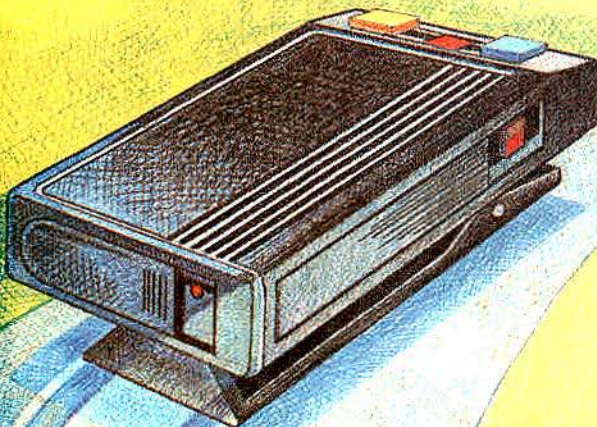
gas and another city to be announced. Federal Express and McCaw will install CDPD modems in all Federal Express vehicles in these two cities, and Federal Express will use AirData services to manage package tracking and delivery through its digitally assisted dispatch system (DADS).

Hutton acquires Canadian company

Hutton Communications, Dallas, has acquired Can+Com Components, Toronto, Ontario, Canada, which will increase Hutton's ability to offer same-day shipment of orders to customers throughout North America. The operating shareholders in Canada will continue with Hutton to ensure a smooth transition.

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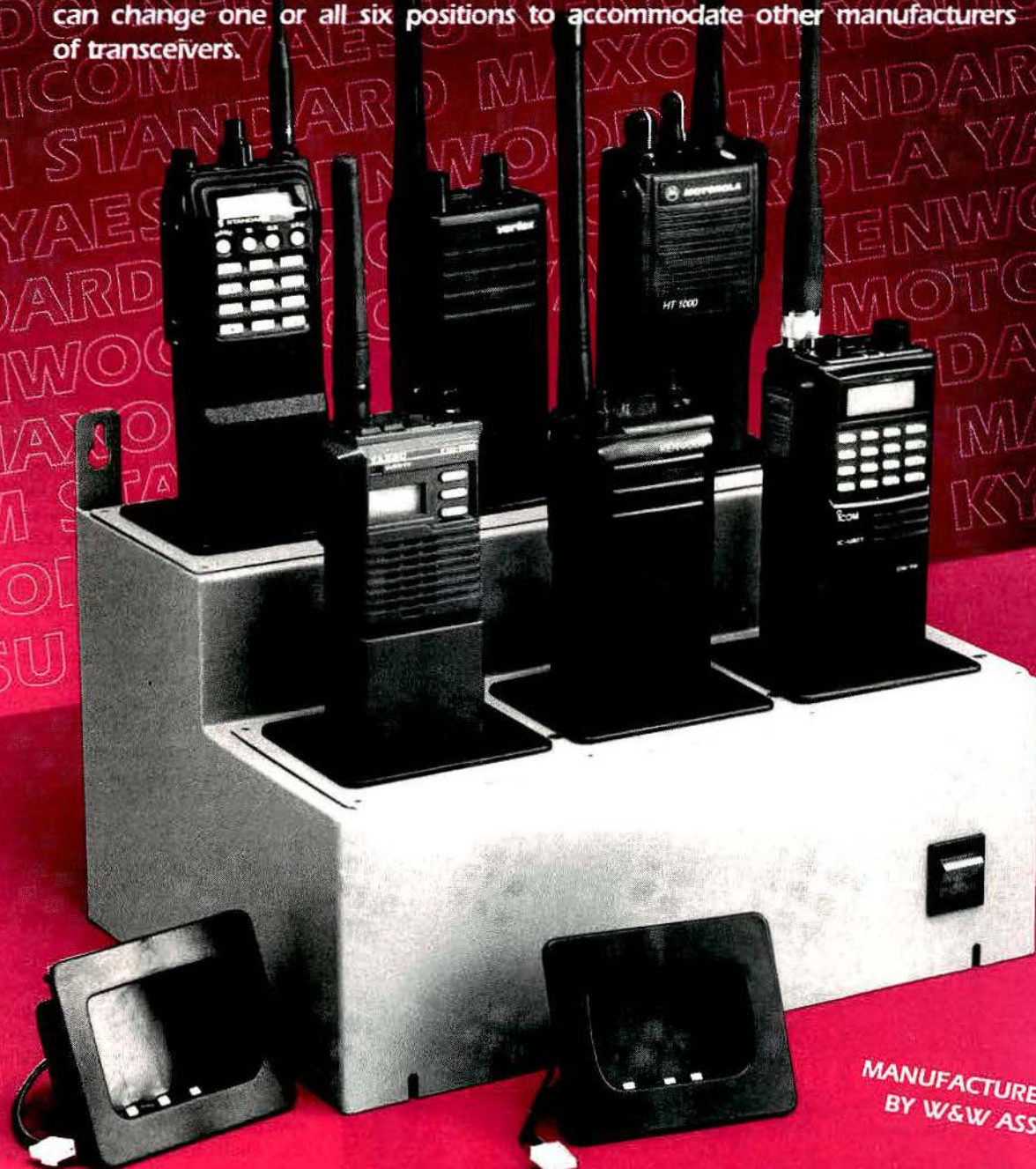
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Motorola settles copyright, trademark infringement lawsuit

Motorola, Schaumburg, IL, has settled a lawsuit against three Chicago-area corporations and two individuals for infringement of various Motorola copyrights and trademarks.

The lawsuit was filed against Creative Radio Services and JHW Enterprises, which were former Motorola dealers, and against Nationwide Radio Communica-

tions, Lawrence R. Johnson and James H. Watson. Johnson and Watson are principals in the three corporations.

Motorola's suit charged the defendants with willfully infringing Motorola's copyrights by illegally reprogramming Motorola's two-way radios using counterfeit copies of software known as Motorola Radio Service Software (RSS). The com-

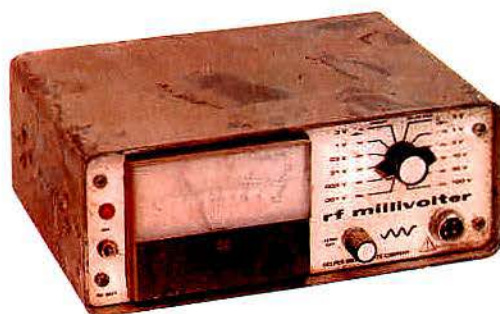
plaint also charged the defendants with willfully infringing Motorola's trademarks by assembling two-way radios from salvage and scrap parts and then selling them as genuine Motorola products.

The defendants were said to have been using the infringing software to program their customers' radios to use one of Motorola's trunked radio dispatch systems on the Sears tower. Instead of paying Motorola for the use of the system, Motorola claimed that the defendants pocketed the money. The defendants agreed to pay Motorola substantial monetary damages and to return all the salvage material, which they claimed they obtained from Motorola.

On July 31, 1993, the Chesterfield Levee broke and flooded the Spirit of St. Louis Airport with 11 feet of Missouri River water and mud.

Jetcorp Aviation was one of the unlucky businesses.

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Hartford, CT, to use portable computing

The city of Hartford, CT, has taken the first step into portable computing with the installation of pen computing technology from Ericsson GE Mobile Communications, Lynchburg, VA. The technology was developed over the last year as a cooperative effort between Ericsson GE, the city of Hartford and IBM. The technology is designed to provide voiceless dispatch, mobile records access and instant reporting by field officers. The system is an extension of the city's two-year-old enhanced digital access communications system (EDACS), manufactured by Ericsson GE.

• In other Ericsson GE news, the company announced the implementation of EDACS Prism technology, which uses frequency- and time-division multiple access (F-TDMA) to expand current channel capability from one user to two or even four users. Nassau County, New York, will offer its existing installation as a test site. Nassau's current communications system consists of a 14-channel, three-site simulcast 800MHz EDACS system. EDACS Prism will increase system capacity while providing backward compatibility. The present Nassau County EDACS system supports about 2,500 users; the expanded system will eventually support more than 5,000 users.

• The RCS Communications Group, headed by RCS Mobile, a five-star GE dealer in Winston-Salem, NC, has moved its headquarters and customer service center to a 26,000-square-foot building on a 17-acre site. The RCS Communications Group sells and maintains communications systems, including two-way radios, pagers, cellular telephones, two-way radio call boxes, voice mailboxes, transmission towers and related services and equipment.

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News

Three companies sign digital technology pacts with Motorola

Transcript International, Lincoln, NE; BK Radio, Lawrence, KS; and Stanilite, Sydney, Australia, have entered into agreements with Motorola's Land Mobile Product Sector, Schaumburg, IL, in which Motorola will license digital technology for the development and production of Associated Public-Safety Communications

Officials—International (APCO) Project 25-compliant public safety communications products. The agreements will accelerate the three companies' development, production and marketing of Project 25-compliant public safety communications systems.

Motorola provides expansion equipment for Tri-State Radio

Motorola Paging Products Group, Boynton Beach, FL, has received an order for 700 Flex-capable Nucleus paging transmitters, C-Net controllers with satellite uplinks and other associated equipment from Tri-State Radio, Fort Lee, NJ.

The equipment is part of Tri-State's ex-

pansion effort. The company was recently granted government approval for a new nationwide paging network. That award, along with expansion into markets in the Northeast, mid-Atlantic and southern California areas, prompted the order.

Dataradio to distribute Motorola RNet radio modem

Motorola's Synapps Business Unit, Schaumburg, IL, has made an alliance with Dataradio, Atlanta, for the distribution of Motorola's synthesized RNet radio modem and telemetry products for the 450MHz to 470MHz frequency band. RNet

products are used for voice and data applications such as SCADA systems for remote monitoring and control of oil wells, pipelines, irrigation, water distribution, community warning and environmental monitoring.

Newly founded Page Call to have headquarters in Fort Myers

Page Call, a new company based in Fort Myers, FL, will distribute paging products from Panasonic, Motorola and NEC and will provide local paging service for its customers, with options to include statewide coverage and nationwide paging. Page Call also will provide consultative and marketing services nationwide for pag-

ing companies and retailers establishing paging sales departments within their existing operations.

Pilot stores will be in Fort Myers, Naples, Cape Coral and Sarasota. These will serve as models and allow hands-on training for those consulting with Page Call to establish operations in their home markets.

Women in Wireless to meet in Tampa

Women in Wireless Communications (WIWC) will hold a continental breakfast meeting in conjunction with the IWCE show in Room 1 of the Tampa Convention Center on Thursday, Oct. 20, at 7:30 a.m.

Liz Sachs of Lukas, Mc Gowan, Nace & Guitierrez will be the guest speaker. Sachs specializes in legal counsel and FCC representation for private and common carrier land mobile and microwave operators. She has been general counsel to the American Mobile Telecommunications Association (AMTA) since its inception. Members and those interested in joining WIWC are welcome to attend. There will be a \$5 charge for members and non-members. Please RSVP by Oct. 1 to Denice Carey at Allen Telecom Group, Cleveland, 216-349-8700; Fax 216-349-8408.

Meridian appointed to manage La Jolla antenna site

Meridian Communications, Calabasas, CA, has been appointed to manage the telecommunications portion of the rooftop of the Coast Building in La Jolla, CA. This antenna site covers La Jolla, as well as many coastal areas to the north and south because of its position adjacent to the ocean.

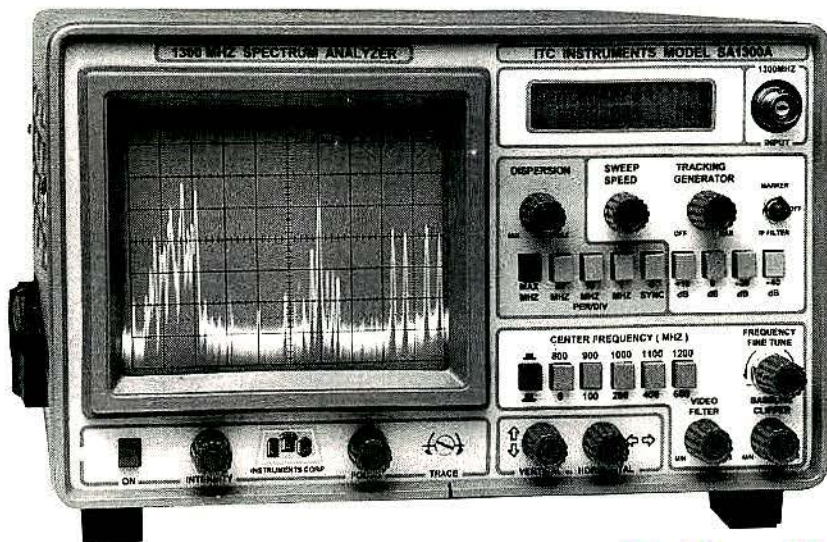
Selectone adds two representatives

Selectone, Hayward, CA, has appointed two manufacturer's representatives. W.A. Hendrickson, North Scituate, MA, will represent Selectone in the New England states, and Communications Marketing Southeast, Marietta, GA, will represent the company in the Southeastern United States.



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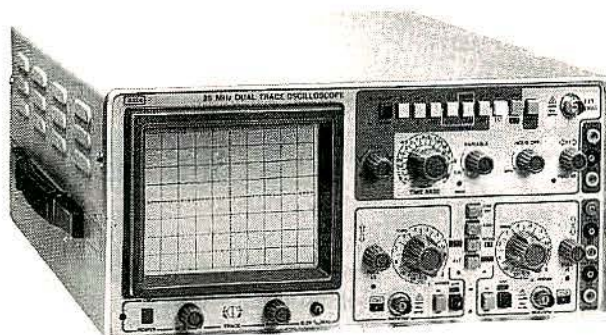
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Mobile antenna mount provides shielding against interior radiation

The MCA 2000 NMO mobile antenna mount from **Richard Hirschmann of America** features full shielding against interior radiation. The fully plated forged brass mount has a constant impedance FME connector for a precise match to feed line and improved performance at high frequencies. The mount is suitable for all land mobile frequencies from 25MHz to 1,000MHz and can handle up to 150W.

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Readers' choice

Of all the new products and services in the March 1994 issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Military format frequency hopper becomes available for tactical use

Radio Systems' PR8077 frequency-hopping radio is designed for low-intensity tactical operations when avoidance of detection by receiver scanners and resistance to single-channel jamming is desired. The hand-held unit is submersible and available in the 60 MHz-88 MHz subband in ± 10 kHz transmit deviation format. Additional subbands are forthcoming in the range between 30MHz and 108MHz. The radio is clear-voice compatible with AN/PRC-77 manpack-type tactical radio equipment. A Transcript International SC460-format encryption option is available for secure single-channel operation. Power output is 1W or 5W, user-selectable.

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Coaxial surge protectors absorb many surges without degrading

Citel America has unveiled a new line of surge protectors for coaxial cable used in mobile radio, radiopaging, cellular and microwave base stations. The protectors shunt excess electricity to ground and reset automatically after every strike. A special patented coaxial gas tube allows the protectors to absorb numerous surges without degrading. Protectors are available in VHF, BNC, F and N types. They maintain transmission characteristic



impedance as high as 2.5GHz.
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VHF mobile radio provides 15W-50W output in 6" x 9" format

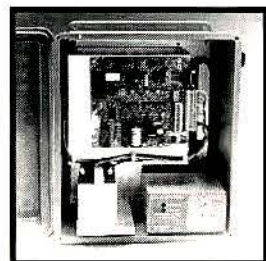
The Bendix/King EMH 599 0A is a 114-channel VHF mobile radio that may be programmed to operate on any frequency in the 136MHz-174MHz range without degradation in specifications. The dash-mount radio from **BK Radio** has an eight-character, vacuum-fluorescent, 14-segment, alphanumeric display. The radio is only 2"H x 6"W x 9"D, but its adjustable power ranges from 15W to 50W. Features include busy channel lockout and indicator, scan, priority scan, CTCSS, DCS, time-out timer, home channel revert, next scan channel and nuisance



channel delete. The EMH is covered by a five-year warranty at no extra charge.
Circle (503) on Fast Fact Card

VOICE REPORTING

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- NEMA 4X case with battery backup
- Respond via DTMF remote control
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- 8 inputs
- On-site paging
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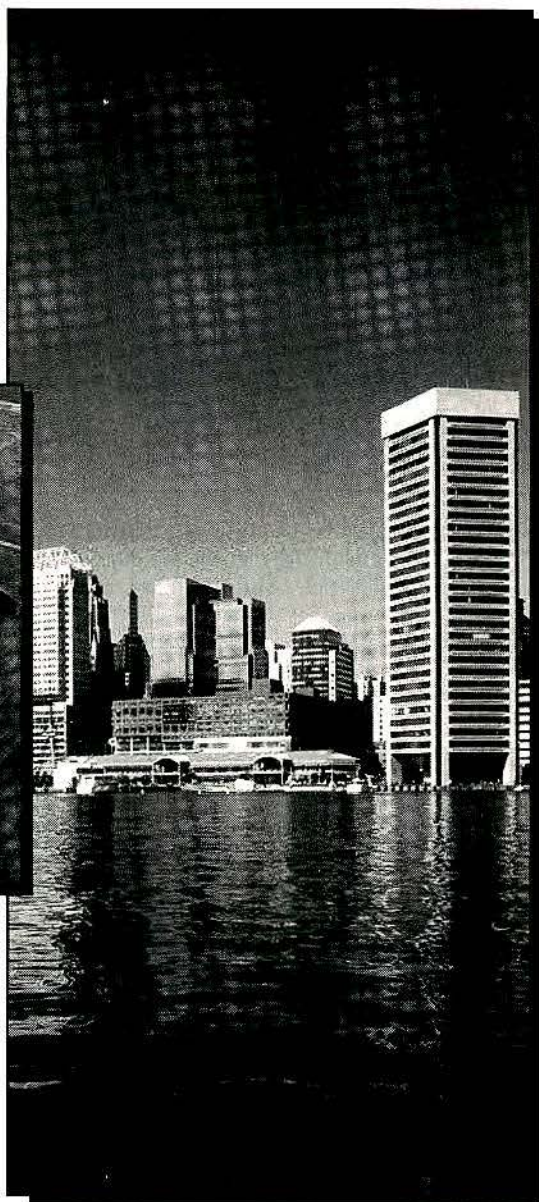
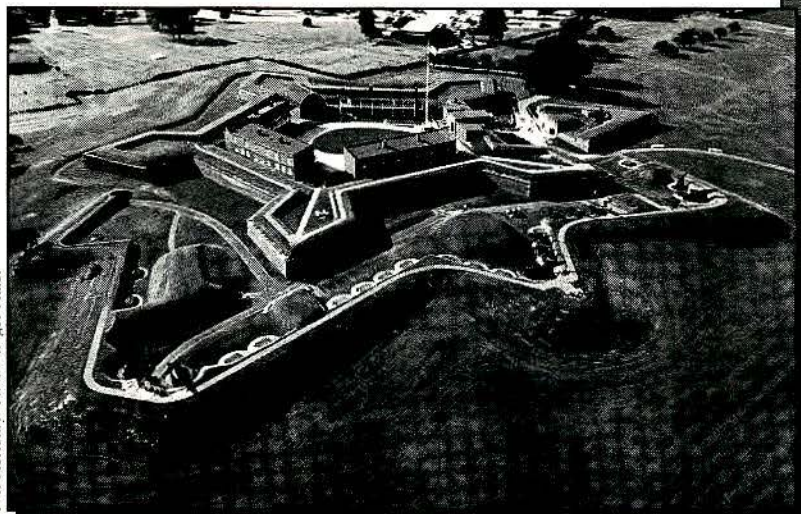
Circle (66) on Fast Fact Card



Feeling
a little
crabby?



Fort McHenry Photo: Roger Miller



Baltimore's Inner Harbor Photo: Roger Miller

Take a break and come join
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Communications Marketing Conference November 10-13, 1994

Be sure to join us this year at the 22nd Annual Communications Marketing Conference. We'll be meeting in historic Baltimore, Maryland – home of the best steamed crabs in America! (And even if you're not feeling a little "crabby" this year, you don't want to miss this excellent sales and marketing opportunity).

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- Tee-off at the exciting industry-wide GOLF TOURNAMENT on November 10.

CMA

COMMUNICATIONS MARKETING ASSOCIATION

New products

Monitoring system automatically relays alphanumeric pager message



The Quick Alert system from **Telemessaging Devices** allows the monitoring of industrial, building, utility, security or other systems by linking standard sensors with alphanumeric pagers. The five-component system includes: sensors; a dialer; the Quick Alert technology which diagnoses the problem and routes the appropriate alphanumeric message to the right person, without operator intervention, within 90 seconds; a paging terminal; and alphanumeric pagers. An English-text message as long as 50 characters can be transmitted.

Circle (450) on Fast Fact Card

System gives individual SMR sites voice mail with message storage

A full-featured voice mail system from **Hark Electronic Systems** has 20 hours of storage and interfaces four analog ports. These ports may be used for taking messages and retrieval of messages as well as dialing out to a pager number

for notification. An optional configuration for the system provides eight ports. The system is optimized to operate with the Hark System product line of DID to SMR interfaces.

Circle (451) on Fast Fact Card

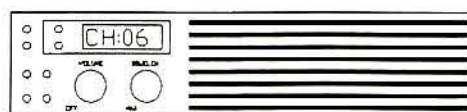
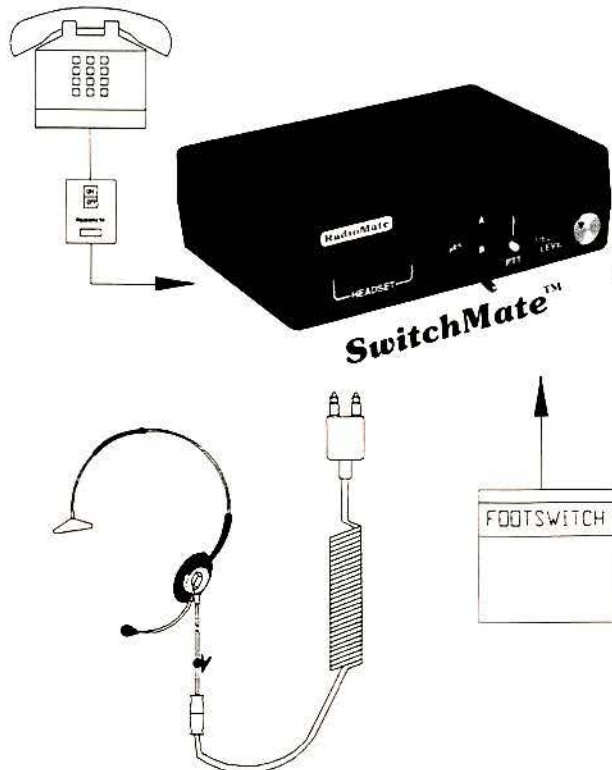
Kink-free, low-loss cable allows direct routing to tower antennas

The $\frac{1}{8}$ " LMR-900 cable from **Times Microwave** has an attenuation of only 1.6dB/100 feet at 900MHz and flexibility equivalent to $\frac{1}{2}$ " corrugated copper cable. An ideal low-loss feeder for tower-mounted antennas, the cable will not kink and can be routed to the antenna without the expense and line loss of a jumper cable. The cable design incorporates an aluminum tape bonded to the polyethylene foam dielectric to form the outer conductor, with an overbraid for connector attachment, resulting in shielding effectiveness greater than 90dB. A weather-proof, UV-resistant polyethylene jacket improves outdoor performance. Type N-male and N-female connectors are also available.

Circle (452) on Fast Fact Card



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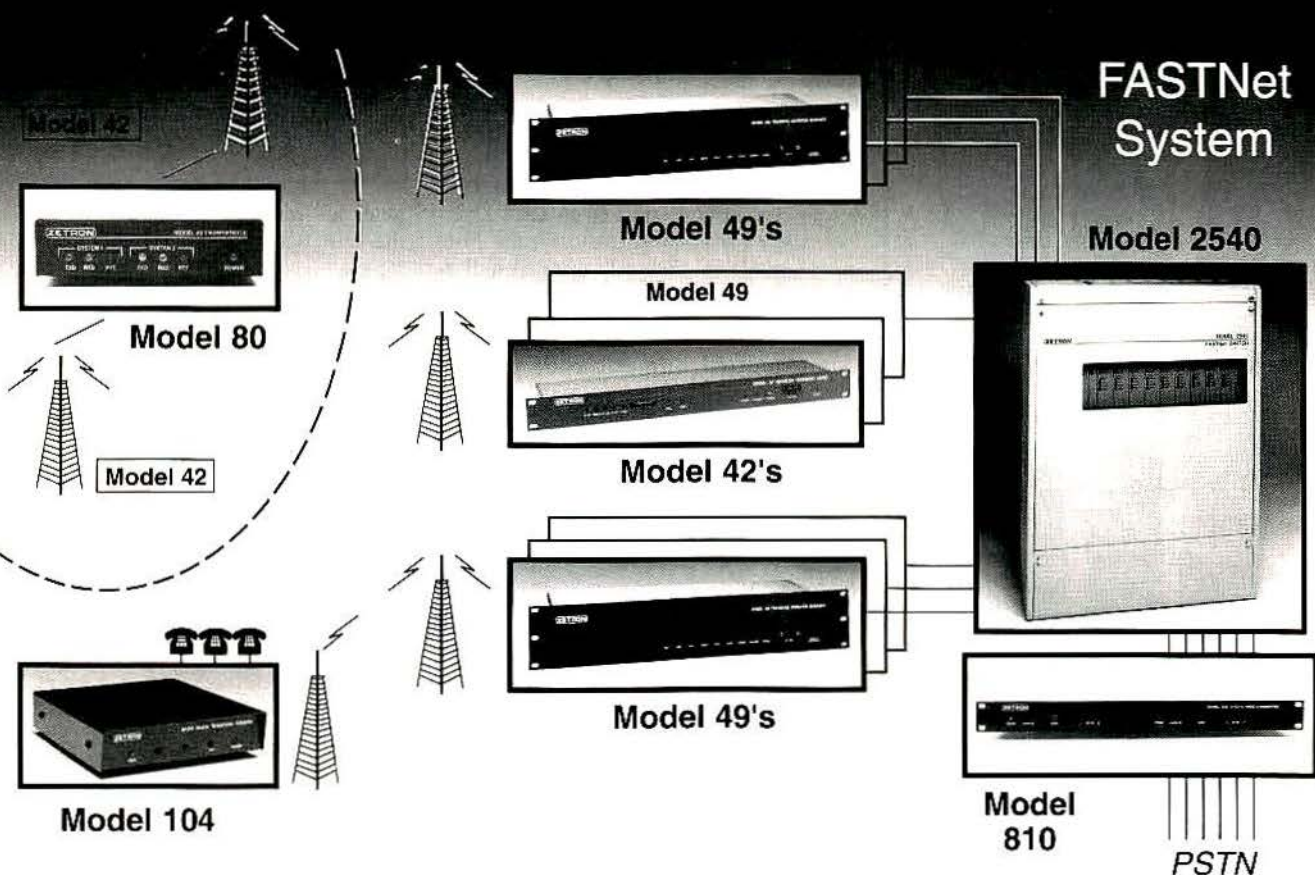
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Total Trunking Technology



Zetron has mastered LTR®-compatible trunking technology. We have the control equipment you need to establish a simple trunked system or to expand into a larger multi-site system. We have the expertise in domestic and international applications to help you meet your needs today and tomorrow.

Model 80 TrunkBridge

Link two or more LTR or conventional radio repeater systems using the Model 80 and two low-cost LTR control stations.

Model 104 Trunked Radio-Telephone Adapter

Connect up to three devices (such as telephones, FAX, or modem) to a radio on a trunked radio system.

Model 49 Trunking Repeater Manager

Provide premium interconnect and dispatch radio capability and effective radio site management with the Model 49.

Model 42 Dispatch Trunking Logic

Control a dispatch-only channel with a Model 42, which has the same innovative dispatch features as the Model 49.

Model 2540 Digital Switch

Form a network between multiple radio sites with a digital switch that provides advanced features for radio operators and users.

Model 810 Digital Hybrid

Significantly improve audio quality of a full-duplex interconnect radio with the Model 810's digital signal processing.

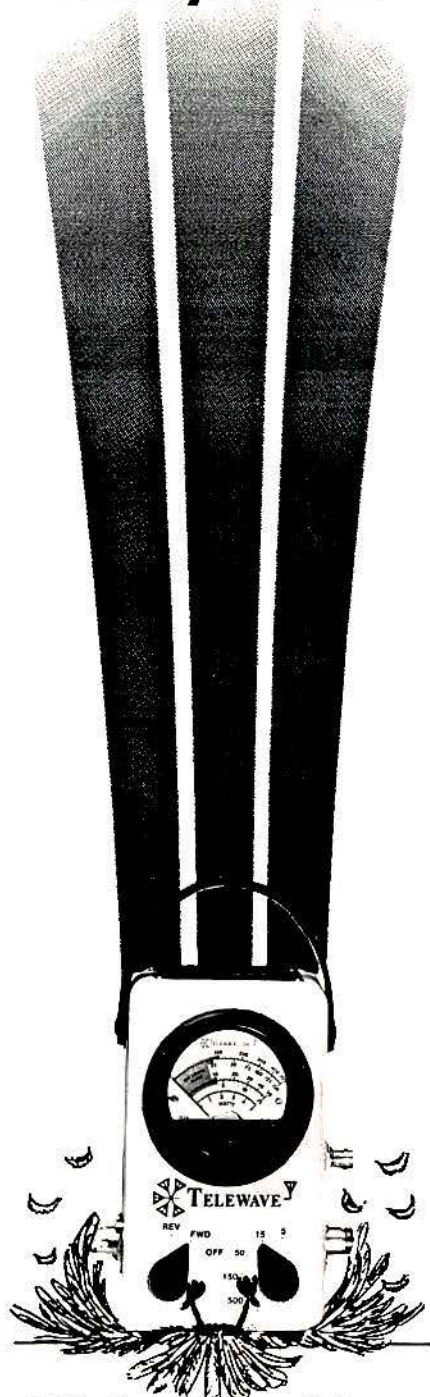
Zetron has earned a reputation for reliable, full-featured products that unite multi-vendor equipment into powerful systems.

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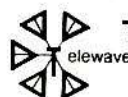
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Circle (70) on Fast Fact Card

New products

Signal-to-noise voter reduces noise, provides voice recognition squelch

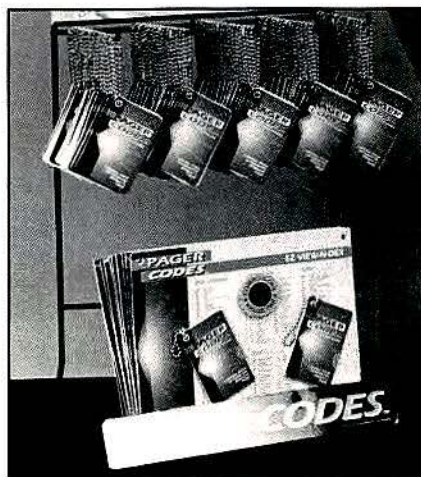
The SNV-4 signal-to-noise voter uses four independent digital signal processors (DSP) to vote the best channel by spectrally determining the S/N ratio of each channel. The voter, from **JPS Communications**, measures the S/N ratio of speech in the input audio of each channel and provides DSP noise reduction and DSP voice recognition squelch on each channel. LED bar graph displays on the front panel give a continuously updated indication of each channel's S/N ratio. No guard



tones are required for measurement, and the unit operates from two-wire audio inputs.

Circle (453) on Fast Fact Card

Standardized numeric code allows numeric pagers to send messages

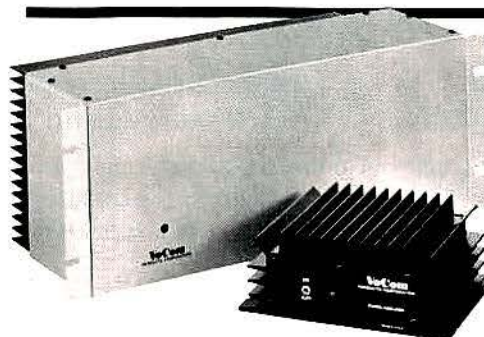


Pager Codes from **REO Enterprises** is a series of proprietary numbered and alphabetized messages that allows numeric

pager users to transmit words and phrases instead of just a return phone number. For example, punching in the series "14*207*330" decodes as "This is (your name). Meet me at the warehouse." In addition to a standardized set of commonly required phrases, the code index provides space for adding code words peculiar to the user's business or life-style. Pager Codes is packaged in two formats. The inexpensive Pocket-N-Dex is a set of five credit-card-size plastic code cards, corner-riveted to fan while viewing, with a convenient attached keychain. The Combo-N-Dex package contains a larger 8" x 10" EZ View-N-Dex card along with two individual Pocket-N-Dexes. Seiko Instruments has bundled the Pager Codes system into its new Pager Pal personal electronic organizer.

Circle (454) on Fast Fact Card

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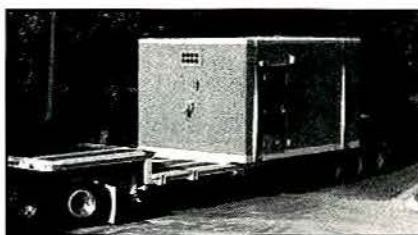
Circle (71) on Fast Fact Card

Improvements in paging software make billing easier for resellers

The improved Page-Lite software package by **Systems Development Corporation (SDC)** allows paging resellers to be directly connected into a paging terminal to activate and deactivate pagers in a matter of seconds. The customer tracking and billing software, distributed nationally by **Cellular Paging Systems**, now also allows resellers to automatically page customers to inform them that their payments are due (or past due). The system selectively sends a voice mailbox phone number and the amount due to each customer's pager. A new Auto-Verify feature reads the reseller's invoice from the paging carrier, provided by the carrier on diskette, and verifies that the reseller is billing a customer for each pager being billed to them by the paging carrier. New paper options for printing billing statements include two-way mailers on which the mailing envelope with postage, the invoice and the return envelope are printed simultaneously. The software has no limits on the number of customers and transactions.

Circle (455) on Fast Fact Card

Reduced-weight concrete shelter offers easier shipping, installation



Andrew's TrussCrete solid concrete equipment shelter weighs 20% less than glass fiber-reinforced concrete shelters and 40% less than other solid concrete

shelters. The weight reduction results in lower shipping costs, improved staging area handling, easier site access and lower crane rental costs. The shelter incorporates Andrew's exclusive space frame reinforcement technology for strength and built-in insulation. Shelters are available in sizes as large as 16' x 40'. They are designed with a seismic zone 4 rating and a maintenance-free exterior. The shelters are covered by a 10-year structural warranty.

Circle (456) on Fast Fact Card

Service area map program plots contours by several characteristics

EDX Engineering has two new versions, 2.0 and 2.5, of its CVR plotting program. CVR plots maps of service area contours for cellular, broadcast, two-way mobile, paging and other VHF and UHF communication services. The program allows plotting of composite service area maps for as many as 1,000 individual transmitter sites or transmitting facilities. CVR performs received power level studies, field strength studies, signal ratio and interference studies, most-likely server

studies and demographic analyses. The program produces on-screen plots for EGA or VGA monitors, pen plots for HPGL-compatible devices, or laser prints on Hewlett Packard Laserjet III-compatible printers. Version 2.0 accesses only U.S. terrain databases furnished by EDX Engineering. Version 2.5 includes additional terrain database information outside the United States.

Circle (457) on Fast Fact Card

VERSA-TRUNK VHF/UHF Trunking For Bendix/King E Series Portables & Mobiles



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Circle (73) on Fast Fact Card

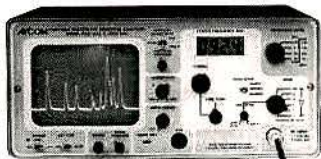
AVCOM's New PSA-65A Portable Spectrum Analyzer

The newest in the line of rugged spectrum analyzers from AVCOM offers amazing performance for only \$2,855.

AVCOM's new PSA-65A is the first low cost general purpose portable spectrum analyzer that's loaded with features. It's small, accurate, battery operated, has a wide frequency coverage - a must for every technician's bench. Great for field use too.

The PSA-65A covers frequencies thru 1000 MHz in one sweep with a sensitivity greater than -95dBm at narrow spans. The PSA-65A is ideally suited for 2-way radio, cellular, cable, LAN, surveillance, educational, production and R&D work. Options include frequency extenders to enable the PSA-65A to be used at SATCOM and higher frequencies, audio demod for monitoring, log periodic antennas, 10KHz filter for .2 MHz/DIV range, carrying case (AVSAC), and more.

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Circle (74) on Fast Fact Card

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Circle (75) on Fast Fact Card

New products

Multiple-user interconnect features internal database, DTMF signaling



The model 737 Rural Patch from Zetron is a multiple-user telephone interconnect with an internal, 1,000-user database and DTMF selective signaling. The interconnect is designed for two-way systems whose radios contain DTMF decoders so that they may be selectively called. Ideal for wireless rural telephony, the model 737 allows radio users to place and receive telephone calls in addition to calling each other. Designed for interface to a repeater, the interconnect operates in half- or full-duplex mode. To support the switching requirements of half-duplex installations, the model 737 provides a

courtesy beep to the phone party when the radio user unkeys and will mask the radio user's side of an interconnected conversation to prevent casual eavesdropping by other mobiles. DTMF connect/disconnect codes, call timers, toll restrictions and Morse ID for the interconnect can be remotely programmed through a Touch-Tone telephone or DTMF radio.

Circle (458) on Fast Fact Card

Updated terrain analysis software provides multiple access, library

Version 3.0 of the Terrain Analysis Package (TAP) radio engineering software from SoftWright adds a batch-processing capability to allow the computer to set up multiple projects and studies without user intervention. A new multi-user capability enables two or more users to access TAP on a local area network (LAN). This saves disk space and makes project files available to other users in the office. Other new features are the ability to locate the highest topography near a possible transmitter site and a large library of patterns produced by antennas from manufacturers such as Scala Electronic, Antenna Specialists, Sinclair Radio Labs, Celwave and Decibel Products.

Circle (460) on Fast Fact Card

Wireless data controller provides error-free transmission/reception

Intended to ensure error-free wireless data communications, the Intelligent Communications Controller Core Module (ICC-CM) from Arrowlink is designed for integration into specialized hand-held and in-vehicle devices. Mediums the module controls include LANs, cellular, trunked radio, PMR, satellite, hand-held PCS devices and PSTN. The module handles applications requiring both voice and data, using proprietary software already in use in mobile applications for emergency road, fire and ambulance services. Features include programmable microprocessor control, on-board memory, real-time input/output features and data speeds as fast as 2Mb/s over radio. The module is generally independent of the application cellular/radio environment, using a library of stored radio type information. Serial and digital input/output ports facilitate connection of a variety of data terminals to the module, including alarms, sensors, computing devices, printers, displays, keyboards, status indicators and mobile data terminals.

Circle (461) on Fast Fact Card

Trunked/conventional radios offer full compatibility with two formats



The HX580T (above left) and HX581T (above right) radios from Standard Communications are dual-protocol portables that are fully compatible with either Motorola Privacy Plus or E.F. Johnson LTR trunking formats, or offer conventional 800MHz operation. Both radios include high-speed programmable scanning; DTMF-, DCS- and CTCSS-selectable tones; time-out timer; busy-channel lock-out; and program-in-the-field capability. The radios also use a nonvolatile memory that stores all frequency and operating parameters without the need for a backup battery. The HX580T also has an alphanumeric display for channel tagging. Options include wall-mount and desktop chargers, on-the-belt speaker/mics, cases and belt clips. The radios are FCC- and DOC-approved and backed by three-year parts and labor warranties.

Circle (459) on Fast Fact Card

Microwave radio addresses FCC requirements on EIRP limitations



Western Multiplex's LYNX.cp2 radio addresses changes in FCC regulations for spread spectrum technology with an adjustable controlled power feature. The feature allows the radio transmitter output power (as much as 1W, like the original LYNX) to be reduced to meet different operating conditions (in-

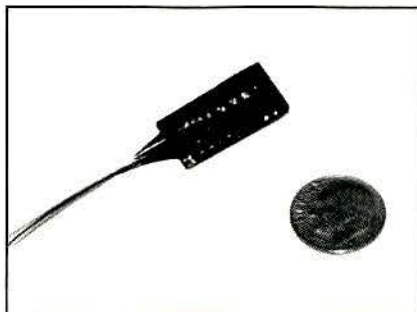
cluding the FCC's +6dBW EIRP limit) and to help in the coordination of a system using multiple transmitters. The control range of this new feature is a 25dB minimum from full power (+28dBm typical, +30dBm maximum, +27dB minimum) to +4dBm. Like the LYNX radio, the LYNX.cp2 provides a full T1, 1.544Mbps data rate and full-duplex throughput, and operates at 2.4GHz. The LYNX.cp2 transmits voice, data and video transparently and uses a standard telco DSX-1 interface. No FCC license is required for user operation.

Circle (462) on Fast Fact Card

Dime-size scan module combines scanning functions in one product

Com-Tech Electronics' revised SCII Minitor II scan module combines priority and nonpriority scan within the same module. The upgrade includes a circuit that eliminates battery drain when scan is not activated. The module provides for scanning in the monitor mode between channels 1 and 2. Working in both the standard and stored voice models, the module allows for alert function during the scanning mode.

Circle (463) on Fast Fact Card



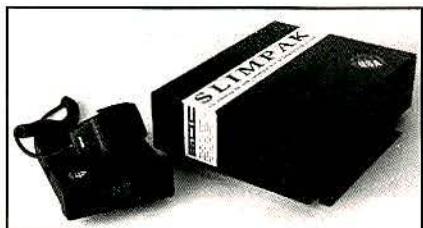
Compact 800MHz repeaters offer 175W output, field programmability

The Summit QX and Viking VX 800MHz repeaters from E.F. Johnson offer as much as 175W of RF power. The Summit QX high-power Multi-Net repeater is a 175W version of the 75W Summit QX repeater developed in 1993. The Viking VX high-power repeater also offers 175W and works in the LTR protocol. The two repeaters are synthesized and field-programmable, and they offer front-panel status and alarm displays, programmable frequency and power output,

diagnostic indicator and RF alarms, and RF amplifier protection. The units combine logic, receiver, exciter and power amplifier into a unit less than 9" high. This allows a standard rack to accommodate a complete five-channel system, including combiner. The Summit QX is designed to public safety specifications, requiring maximum coverage and signal penetration. The Viking VX is designed for SMR and private system operations.

Circle (464) on Fast Fact Card

Slim-profile radio offers scanning and programmable frequencies



Offering a slimmer profile and several operating head choices, the SG-2000SP Slimpak HF SSB radio from SGC is ideal

for tight mobile installations. The radio, which measures 3.6" x 10.1" x 13", has the same technology and rugged design as SGC's SG-2000 model. The Slimpak has 644 ITU and ham frequencies, including SITOR telex channels, permanently etched into memory, 100 user-programmable frequencies and scanning features. Heads are also available for marine and aviation uses. The mobile head model covers 2MHz-22MHz at 100W output.

Circle (465) on Fast Fact Card

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Circle (76) on Fast Fact Card

New products

High-capacity NiCd battery line matches OEM design standards

The Americas Parts Division of **Motorola Land Mobile Products** has introduced the Mag One Battery line of high-capacity, long-life, replacement NiCd batteries for non-Motorola radio users. The list of non-Motorola radios that Mag One batteries are engineered for in-

cludes E.F. Johnson, Ericsson GE, Icom, Kenwood, King, Midland, Regency/Standard, Repco/RCA, Ritron, Wilson and Yaesu. The batteries are designed and built according to the OEM standards for each brand.

Circle (466) on Fast Fact Card

Surge protector uses hybrid circuit to protect telephone and data lines

Citel's one-, two-, three- and four-pair surge protectors use a hybrid circuit for protection of telephone and data lines. A three-element gas tube on the input stage provides a high discharge capacity (>5,000A), and a

solid-state diode on the output stage provides a response time of less than 1ns. A fail-safe device protects against unusual surges such as power line crosses.

Circle (467) on Fast Fact Card

Software organizes customer records for trunking management, billing

Pacific Circuit Design's Trunking Customer Organizer software manages codes, radio serial numbers, lists of active mobile and portable units, loading history and bill-

ing. The IBM PC-compatible software allows report printing on the various features for all types of trunking systems.

Circle (468) on Fast Fact Card

Composite materials decrease cost, increase comm mount strength

Slimline 2000 mobile communications mounts from **Pana-vise** are constructed of a fiber-reinforced composite material to increase durability and gripping strength of each unit and to decrease cost. In addition to the composite mounting plate, shaft and foot, the kit includes universal joints that allow 210° of pivot and 360° of swivel. The mounting kit comes with an NEC/AMPS-compatible mounting plate with setscrew or knob adjustments. Two rises are available, 6" or 9".

Circle (469) on Fast Fact Card



ENCODEDERS

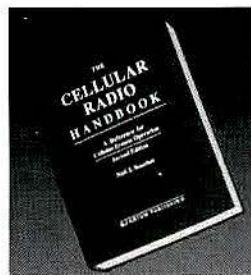
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Circle (77) on Fast Fact Card



The Cellular Radio Handbook

This best seller has rapidly become the industry standard reference that explains the intricacies of designing, installing and operating a worldwide cellular network. This second edition includes 42 chapters and over 300 illustrations. 765 pages \$185

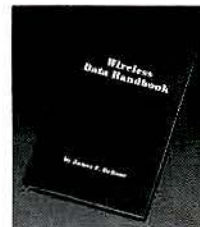
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The Paging Technology Handbook

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Circle (78) on Fast Fact Card

Weatherized grounding kit offers reduced resistance and inductance

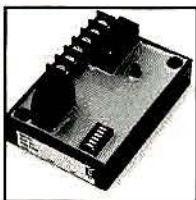
Polyphaser's Uni-Kit 2 cable grounding system integrates a weather-protected copper strap as a conductor to provide an improved surface area connection to the cable that reduces the inductance. The strap also reduces the resistance path to ground. The design fits cables from 1/4" to 2" in diameter and

elliptical waveguides as large as EW28. Standard weatherizing materials are included to seal the connection. The ground connection end of the strap is specially coated to minimize dissimilar metal problems when bonding to galvanized towers.

Circle (470) on Fast Fact Card

Relay triggers alarm, spare lamp in the event of tower lamp failure

The SCR630T universal electronic lamp alarm relay from SSAC senses obstruction lighting failures on radio towers. The unit monitors from one to four steady or intermittent lamps. The number of lamps, their wattage and their voltages are set with six switches



on the unit. The alarm relay's toroidal transformer monitors the current in the lamp wiring. A current drop due to lamp failure causes the relay's LED to light and its output to transfer. Two outputs are available for a backup lamp and a remote alarm. A trip delay prevents nuisance tripping. The SCR630T operates on 230Vac 50/60Hz. Circuitry is sealed for reliable operation.

Circle (471) on Fast Fact Card

Digital communications product line uses F-TDMA to expand capabilities

EDACS Prism is a family of base stations, mobile radios and portable units using frequency-and-time division multiple access (F-TDMA) technology to expand the capability of a current channel from one user to as many as four users. Part of Ericsson GE Mobile Communications' Enhanced Digital Access Communications System (EDACS) product line, EDACS Prism increases system capacity while providing full backward compatibility. Allowing users to increase spectrum efficiency without the need for

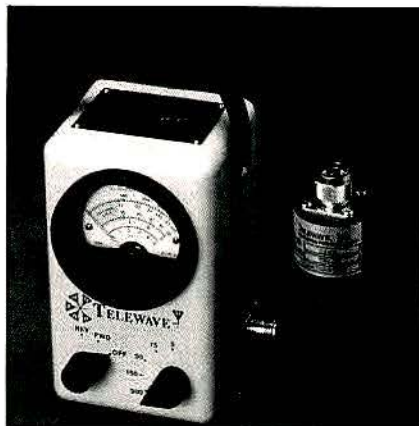
additional frequencies, the system allows a channel-by-channel upgrade for a seamless migration path based on users' needs.

Circle (472) on Fast Fact Card

Antenna replacements are offered in halfwave, quarterwave versions

Replacement antennas for the Standard HX580 radio are available from the Land Mobile Division of Centurion International. The injection-molded antennas are made with SMS connectors. Two versions

Field testing wattmeter specializes in 25MHz-1,000MHz broadband



Telewave's RF Wattmeter for remote field testing needs no additional slugs or inserts for different power levels and applications. The meter, which requires no band switching, specializes in 25MHz-1,000MHz broadband. The unit has five scale ranges (5W, 15W, 50W, 150W and 500W) and provides direct measurement of forward and reflected power with type N in-line connection. The meter covers cellular bands and most remote and control links. Basic meter accuracy is $\pm 5\%$.

Circle (474) on Fast Fact Card

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Return Loss Bridges

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RLB150 bridges can be used with spectrum analyzer/tracking generator or service monitor for swept SWR measurements. This technique simplifies tuning of antennas, cavities, duplexers, isolators and many other RF devices. They also can be used for cable insertion loss and impedance measurements.

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Circle (81) on Fast Fact Card

New products

Hand-held radio receiver employs extremely wide frequency range

The wide-range, hand-held Trident TR2400 radio receiver from Ace Communications covers virtually all voice broadcast frequencies, from 100kHz to 2.06GHz. Its demodulation modes are AM for broadcast, world-band and for civil and military aviation; narrowband



FM for police, fire and emergency transmissions; wideband FM for radio and TV audio broadcasts; and single sideband for transoceanic aircraft and ships at sea. Desired frequencies are entered on a keypad, and entries are displayed on a backlit LCD. The unit searches for active channels and allows the user to store as many as 1,000 locations in permanent memory. Power is supplied by four AA batteries. Audio is heard through the built-in speaker or the supplied earphone. Other accessories include a 12Vdc dashboard plug, ac battery charger, belt clip, flexible antenna and mounting hardware.

Circle (475) on Fast Fact Card

System interfaces with cellular networks for public safety applications

The ML500 Multiline Stationary Cellular System from TransTel Group provides communications backup and restoration, security monitoring and temporary site service applications. The ML500 provides an interface to cellular networks for existing voice and data communications equipment. Particularly useful for public safety applications, the system can be configured for one to five lines per chassis. Multiple chassis are employed to provide the required number of lines in high-density applications. The system provides dial tone, ringing current and standard tip and ring connections. The standard telephone interface allows the use of existing conventional voice and data communications equipment, eliminating the need to

buy equipment designed specifically for cellular applications, while simplifying backup communications system design. System applications include backup enhanced 9-1-1 service where the ML500 is located at the public safety answering point (PSAP). If landline connections are lost during a natural disaster, communications can continue uninterrupted via cellular connections to the PSAP. Data transmission rates are 14.4kbps or faster, depending on the modem used in the application. The ML500 system can be installed on the line or trunk side of the PBX. Each chassis houses as many as five transceiver models and operates with 110Vac to 12Vdc at 21A or -48Vdc to 12Vdc at 20A.

Circle (476) on Fast Fact Card

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Contact the factory for our complete product information and our series of technical articles on antenna site applications. EMR manufactures RF filters from 66 MHz to 1.3 GHz.

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Circle (82) on Fast Fact Card

Software enables remote connection to network for mobile computing

MobileWare's MobileWare 1.0 intelligent access software enables mobile users to connect to the corporate local area network (LAN) via wireless or landline connections. The software allows users to send and receive E-mail, faxes, files and printed documents. Users can continue working while transactions are being completed in the background. When a connection source is not available, MobileWare 1.0 will accept commands for sending information and will complete the transaction once the connection resource becomes available. If a user is disconnected during a data transmission, a dynamic reconnection protocol automatically reestablishes the connection and continues the transmission from the point the drop occurred, without any loss of information. The software supports analog circuit-switched cellular and standard phone lines when remote, and direct LAN connections when in the office. The product also includes data compression for faster transfer and data encryption for security.

Circle (477) on Fast Fact Card

Indoor/outdoor ground alert system monitors resistance in ground field

Two models of ground field monitors, a panel-mount model and a rack-mount model, are available from **Lyncole XIT Grounding** for indoor or outdoor installations. Both continuously monitor resistance of the ground field and trigger an

automatic alarm when resistance rises above a preset level. The monitors feature front-panel controls, an LCD readout in ohms by 0.1Ω increments, a test current LED, and a trip indication LED.

Circle (478) on Fast Fact Card

Telemetry radio with optional digital modem allows user-programming

The DL-3472 synthesized UHF data telemetry radio from **E.F. Johnson** is available at 403MHz-512MHz with standard frequency splits. The module, for which an optional 9,600 baud telemetry modem has been developed, has been upgraded to operate at 12Vdc. Standard features include user-programmable frequencies, selectable baud rates, and TTL or RS-232 interfaces. These features enable fast polling routines for customized

communications. The telemetry modem, model DL-3295, is interconnect-compatible with all E.F. Johnson telemetry products. The modem incorporates a digital signal processor to provide the user with programmable speeds of 9,600bps, 4,800bps, 2,400bps, 1,200bps and 300bps asynchronous data, or an independent data mode supporting 0bps to 4,800bps, including POCSAG paging formats.

Circle (479) on Fast Fact Card

Lightweight microcell antenna design targets indoor wireless networks

Indoor microcell antennas are available from **DAPA Communications**. The compact, low-profile antennas are designed for 890MHz-960MHz indoor wireless networks, including microcell and GSM.

Two models are available: a unity gain omni and a 115°, 4dB panel. Each model weighs less than 2 pounds and is enclosed in a 6"-diameter radome.

Circle (480) on Fast Fact Card



Remote Comparator Display

The Smartswitch II™ Remote Comparator Display monitors and controls voting receiver systems on a personal computer or console. It can be used locally or remotely with leased-line or dial-up modems.

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Circle (83) on Fast Fact Card

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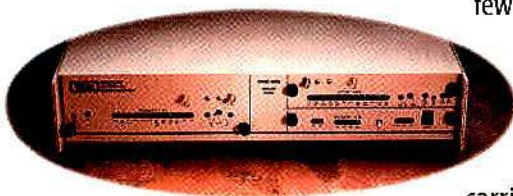
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New products

Software allows use of text pager for messaging, Internet connection

AirNote, from **Notable Technologies**, is a wireless mobile messaging package. The program formats computer typed messages, E-mail, Internet communications and phone messages for display on a text pager. The AirNote package includes software, text pager, personal Internet address, free activation of network and operator services, and one-call customer support. Messages can be typed into a modem-equipped personal computer at the user's office, using AirNote's software, which then can be sent immediately to the user. E-mail messages can be sent from any computer with Internet access by addressing them to the user's AirNote pager's unique Internet address. The AirNote pager can receive messages from any on-line system with access to the Internet, including America Online, AT&T EasyLink, CompuServe, GEnie, MCI Mail and Prodigy. Messages can be

sent from any telephone through an 800 number. AirNote users receive the message just as it was dictated to the 800-line operator. Additionally, users of Windows and Lotus cc:Mail, Lotus Notes Mail or Microsoft Mail can have E-mail messages automatically forwarded to an AirNote pager. This AirNote feature allows users to screen messages by including or excluding specific senders, prioritizing messages or identifying text keywords. AirNote software operates on IBM-compatible PCs running Windows 3.1 or later with 2MB RAM, or PCs running DOS 5.0 or later with 640K RAM, or on Macintosh System 6.0.5 or later with 1MB and System 7.0 or later with 2MB RAM. A 300 baud or faster modem is required. Notable Technologies also offers monthly service plans through affiliations with **PageNet** and **SkyTel**.

Circle (481) on Fast Fact Card

Parabolic reflector shield protects antennas from deterioration, wildlife

The DS-90 protective shield for parabolic reflectors attaches to the upper periphery of a shrouded high-performance antenna. The shield, from **Kalartek**, increases the life span of the radome by protecting the radome edges from damage from birds, UV deterior-

ation, airborne pollutants and falling ice. One installer can place a shield in 15 minutes. The shield, made of T-60-63 grade aluminum with stainless-steel hardware, is certified to withstand 120mph winds.

Circle (482) on Fast Fact Card

Portability, weatherproofing highlight repeating base station features

Earmark's Basemaster VIII is a full-featured duplex repeating base station that is completely portable and weatherproof. The station supports both Earmark's Belt-Pak and Headset Duplex radios. The compression-molded case seals tight with four roll-over clamps to provide environmental isolation. All the electronics reside under a heavy aluminum control panel, supported by a base-mounted steel plate. The sealed back panel, with headphone and antenna access, allows station operations in inclem-

ent weather. Powered by a 5Ah SLA battery, the station operates in normal transmit mode, free of external power, for as many as 24 hours between charges. Power Plus, Earmark's transmit power enhancement (950mW) is built-in and accessible with a control panel-mounted toggle switch. The external telephonic accessory port is switchable from standard telephone to cellular phone. Optional adapter packs are available to complete these circuits.

Circle (483) on Fast Fact Card

Portable CDMA spectrum analyzer offers interactive troubleshooting

Hewlett Packard's portable CDMA spectrum analyzer offers customized, one-button transmitter measurements and interactive troubleshooting capabilities. Tests include power, timing and frequency-interference standards. The portable analyzer combines the HP 85725A CDMA measurements personality and an HP 8590 E-series spectrum analyzer. When loaded into the spectrum analyzer, the CDMA personality configures the

soft-key user interface for customized CDMA testing. Research and development engineers and technicians who design CDMA base station, mobile or portable transmitters can use the analyzer to test radio designs for RF link performance. Manufacturers can use the analyzer to develop production-test processes and to perform troubleshooting and repair.

Circle (484) on Fast Fact Card

Automated paging network system measures, records spectrum usage



The Pagetracker 2000 from the Grayson Electronics division of **Allen Telecom Group** is a measuring and monitoring system for designers, operators and installers of worldwide paging, personal communications services (PCS) and land mobile systems. The system automatically measures and records spectrum usage and signal levels at frequencies as

high as 2,000MHz. It is ideal for automated interference measurement or carrier-to-interference studies in paging, cellular, PCS, specialized mobile radio (SMR) or any other land mobile radio band. A custom scanning capability allows paging service providers to scan and store as many as 1,024 discrete frequencies. With a PC using ASCII files, Pagetracker 2000 provides organized lists of paging traffic and radio frequency (RF) activity with rapid retrieval and analysis. Grayson's Truly-Ready-for-Use-by-Everyone (TRUE) user interface provides IF filter bandwidths, signal thresholds, scanning dwell times and quick and easy scanning increment adjustments.

Circle (485) on Fast Fact Card

Antennas offer durable construction for operation at 2.2GHz-2.9GHz

Maxrad's (B)MAXC-24503 and (B)MAXC-24505 2.2GHz-2.9GHz antennas are available in black or chrome, with a molded polymer base. The antennas have a spring-loaded contact pin and a 0.100"-diameter stainless-steel whip for long-lasting, trouble-free service. They

are factory-tuned to 2.45GHz, available in either 3dB or 5dB gain (with 100MHz and 75MHz of bandwidth at 1.5:1 VSWR, respectively). The antennas feature a closed-coil design.

Circle (486) on Fast Fact Card

Solar-rechargeable batteries make cellular phones more independent

The SolarLife Division of **Bel-Sound** now offers solar-rechargeable cellular telephone batteries, including batteries designed for Motorola flip-phones. SolarLife offers four charging options: solar, home/office rapid-charge, car rapid-charge and trickle charge. Solar-charging takes place automatically as long as the battery is in daylight, whether it is in the phone or not, even during calls. Exposure to direct sunlight is not necessary for recharging.

Circle (487) on Fast Fact Card

High-power cellular harmonic filter features one-piece construction

The LB-B60 lowpass filter from **Microlab/FXR** has a passband of 869MHz-894MHz. Power handling is 600W. Insertion loss is less than 0.2dB. The high-power cellular harmonic filter features one-piece construction to improve reliability and unit-to-unit consistency. The length is 4.7", including type "N" connectors.

Circle (488) on Fast Fact Card



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Book includes reports on new communications technologies

Communication Technology Update provides professionals, college professors, students and government leaders with in-depth descriptions of 38 new technologies and their applications. The book from **Focal Press** includes chapters on radio techniques, computer technology, LANs and WANs, global positioning, satellites, VSAT, fiber optics, ISDN, cellular tele-

phone and personal communication networks. Each chapter covers a specific communication technology and includes a synoptic history of the technology; a thorough description of the technology and its applications; a review of the latest developments and trends; and a bibliography and literature review.

Circle (300) on Fast Fact Card

Video training course covers communications test set

A video training course jointly developed by **Sage Instruments** and **AT&T Network Education & Training International** covers the theory and operation of Sage's model 930A communications test set. Students are visually guided through the course material and are provided with a user guide, which includes defined objects and self-paced tests. The eight-hour video is divided into four units: equipment set-up; transmission measurements; signaling and supervision; and PCM testing. The course is available in VHS, SECAM and PAL formats.

Circle (301) on Fast Fact Card

Market research publications describe paging, PCS industries

The State of the U.S. Paging Industry: 1994 from **Malarkey-Taylor Associates/Economic and Management Consultants International (MTA-EMCI)** contains an analysis of the emerging trends among paging carriers and subscribers, as well as new technologies and narrowband personal communications service (PCS) advanced messaging services. Also available from

Catalog covers hand-held radio batteries

A 20-page catalog describes **Multiplier's** line of replacement batteries and eliminators for two-way hand-held radios, pagers, flashlights, cordless phones and test equipment. Included is a section for custom battery replacements, as well as a section that refers cellular customers to the 1994 cellular accessories guide.

Circle (302) on Fast Fact Card

MTA-EMCI is *The PCS Market Data Book*, a data resource for potential PCS businesses. It contains maps and statistical tables that provide information on the population growth, median household income, interstate miles and number of businesses at the MTA, BTA and county levels.

Circle (303) on Fast Fact Card

Catalog displays more than 200 antennas

A catalog from **Maxrad** features more than 200 new models of land mobile, cel-

lular and base station antennas and related accessories.

Circle (304) on Fast Fact Card

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Unique programmability allows the user to create a sophisticated closed loop control system capable of automatic alarming. **ProTek's** inputs accept contact closures and DC voltages. The user defines input limits, time delays, qualifiers and relay outputs to be controlled. Any active input can be programmed to place an alarm call.

An integral modem and speech synthesizer allow **ProTek** to alert you to inputs out of limits by calling a person, pager or computer (up to 8 phone numbers in any combination). You can call **ProTek** from any tone telephone and it will tell you the actual value of any input (in volts, watts or high/low level). Using the telephone, you can control all relay outputs and listen to audio inputs.

Time-stamped event recording (stored in non-volatile memory) helps pinpoint intermittent problems. Best of all, no special computer software is required to program the unit - any Video Display Terminal can be used since all user-friendly screen software is resident in **ProTek**.

To find out more about the **ProTek** family of Monitoring, Alert and Control Systems, give us a call at (919) 876-8294 or FAX (919) 876-5666.



ProTek is field expandable - up to 128 inputs, **ProTek** has 14 inputs and 8 outputs.

Circle (90) on Fast Fact Card

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Book provides overview of Industrial Electronics CET test

Industrial Electronics for Technicians by J.A. Sam Wilson and Joseph Risse provides an overview of the topics covered in the Industrial Electronics CET test. The book from **Prompt Publications** covers the theory and application of industrial hardware from the technician's perspective, giving the necessary explanations for

Circle (305) on Fast Fact Card

Master catalog features specialty tool kits, cases

The 1994-1995 master catalog from **Jensen Tools** features specialty tool kits and cases, plus the latest portable field test instruments from major manufacturers. Included are hard-to-find tools, static con-

Circle (306) on Fast Fact Card

Market data book gives electronics overview

The 1994 *Electronic Market Data Book* provides detailed information on electronic sales, trade and economic trends and presents profiles of the following industry sectors: telecommunications; computers and peripherals; consumer electronics; electronic components; defense electron-

ics; government electronics; industrial electronics and electromedical electronics. The book from the **Electronic Industries Association** contains more than 250 pages and includes tables and other graphical elements.

Circle (307) on Fast Fact Card

Technician certification study guide emphasizes digital technology

The "Technician Certification Study Guide and Sample Exam" is available from the **National Association of Business and Educational Radio (NABER)**. The updated guide emphasizes computers and digital technology. Included are a revised study reference section, a new section to help candidates locate items in the sample exam by topic and an improved, detailed section to clarify responses to exam questions. The sample exam covers the following topics: Theory—two-way radio and communications systems technology; Measurement and analysis—fault analysis, metrology and instrumentation; Rules and specifications—FCC rules and regulations.

Circle (308) on Fast Fact Card

Catalog features filter products

A 16-page wireless catalog from **Loral Microwave-Narda West** covers a competitive selection of isolator, circulator and filter products designed specifically for SMR, cellular and PCS applications.

Circle (309) on Fast Fact Card



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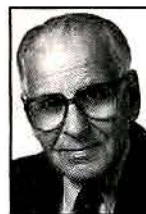
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P eople



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Little

Robert Schwendeman, vice president and senior member of the technical staff, Motorola, Boynton Beach, FL, receives the Technology Award for technological innovation and excellence from the Personal Communications Industry Association (PCIA), Washington, DC.

Fred M. Link, MRT's industry consultant, receives the Chairman's Award from PCIA. The presentation of the award was timed to coincide with Link's 90th birthday, and it is "the industry's tribute to him in honor of that occasion as well as his important role in the development of wireless communications," the citation from PCIA reads.

Lisa Witherspoon leaves Marconi's Reston, VA, office where she did technical backup and marketing for Inmarsat products to become sales manager for Inmarsat products for ViaSat Technology, Hauppauge, NY.

David Little departs Decibel Products, Dallas, as a systems engineer to join Talley Communications, Santa Fe Springs, CA, as systems engineer. He will be based out of the company's Phoenix, AZ, location.

David B. Lowry departs U S West International, London, as executive director of operations and engineering to join Columbia PCS, Alexandria, VA, as vice president and chief technical officer.

J. Sharpe Smith leaves the Cellular Telecommunications Industry Association, Washington, DC, as public affairs writer and editor of the "Wireless Communications Forum" to join the Industrial Telecommunications Association, Arlington, VA, as communications and public affairs manager and editor of "Telecom Exchange."

Steve Chappell exits the Nashville, TN, sales office of Celwave, Marlboro, NJ, as a customer service representative to join Hutton Communications, Dallas, as office manager for the Atlanta branch.

Carol Swartz leaves BellSouth Mobile Data, Atlanta, as international development director to join Coded Communications, Carlsbad, CA, as international operations vice president.

Jim Nelson departs Arch Communications, Albany, NY, as vice president and general manager to join TGA Systems, Atlanta, as vice president.

Winfield Donat leaves the U.S. Navy as superintendent of the U.S. Naval Observatory, Washington, DC, to become president of Lawrence Behr Associates, Greenville, NC.

Clarke H. Bailey, vice chairman of the board of directors for Glenayre, Duluth, GA, adds to his responsibilities by becoming its executive committee chairman.

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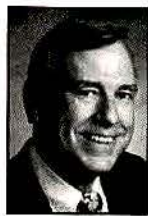
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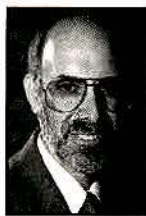
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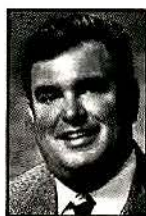
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Tindall



Victor



Hinthorne



Friberg

James Tindall exits ComMar, ICOM's Northeast marine dealers' representative in Annapolis, MD, to join ICOM America, Bellevue, WA, as marine division manager.

Alan Victor ceases doing business as the owner of RF Consultants, Cooper City, FL, to join JTech, Pompano Beach, FL, on a full-time basis as senior vice president of the on-premise paging division.

Rick Hinthorne leaves Components Center in southern California as vice president and general manager to become national sales manager for Larsen Electronics, Vancouver, WA.

Magnus Friberg leaves ITT Grindex in Illinois, as regional manager to join Allgon Mobile, Grand Prairie, TX, as national sales manager for mobile antennas, North America.

Brian S. Mudge leaves Motorola's Telepoint Systems Division in Europe as international sales director to join Newspaper Group Int'l., Berks, United Kingdom, as managing director. Newspaper Group Int'l. is a subsidiary of Newspaper, Dallas.

Joe Galleli exits Ram Mobile Data, New York, as product manager for public safety agencies and utilities in its Winter Springs, FL, office, to become senior manager at SCL Systems, Woodbridge, Ontario, Canada, in its U.S. office in Orlando, FL.

Bill Reich, publications manager for Loral Microwave-Narda, Hauppauge, NY, advances to manager of sales administration.

Jon Sullivan, design engineer for Centurion International, Lincoln, NE, moves up to design engineering manager.

Changes at Ericsson GE, Lynchburg, VA:

Barbara Baffer, regulatory analyst for Ericsson GE, advances to manager of regulatory programs.

Bill Blackburn, manager of regulatory programs, moves up to manager of GE Cellular Systems Operations for Ericsson GE.

Stephen Sitton leaves the Dallas/Ft. Worth property for Southwestern Bell Mobile Systems as vice president and general manager to join Cellular One, Greenbelt, MD, as president and general manager.

Robby Hill leaves PowerSpectrum in New Jersey as systems technical manager to join SmartLink, Wallingford, CT, as manager of technical field support services.

Martin Cooper adds to his responsibilities as chairman and president of ArrayComm, San Diego, by being appointed to the board of directors of Spectrian, Mountain View, CA.



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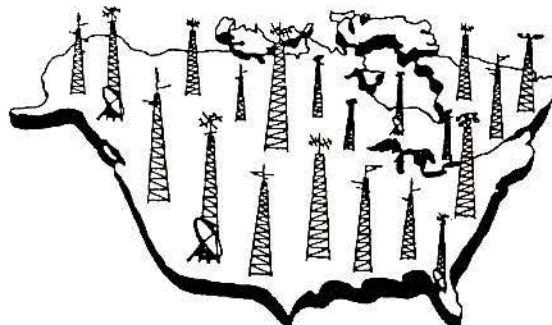
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L

etters from readers

The toughest problems facing me on the job are:

- Convincing customers to buy equipment that is expandable for future use.
- Troubleshooting equipment where the installer left no documentation.

Lynne Winchester
Northeastern Communications
Ashtabula, OH

The two toughest problems facing me on the job are:

- Determining our next product.
- Determining who is going to buy it at what price, in what quantities and at what time.

Andrew Lovas
San Francisco Telecom
San Francisco

The two toughest problems facing me on the job are:

- Convincing my customers to buy what they need.
- Competing with the big companies.

David L. Hart
Hart Tek Electronics
Unalaska, AK

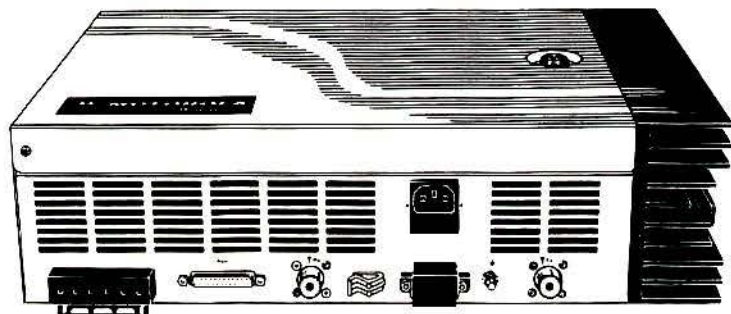
The toughest problems facing me on the job are:

- Finding individual parts.
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Correction

Due to an editorial error, the following chart was not included in Part 9 of David Ludvigson's pager series in the September issue of *MRT*, "Servicing pagers: 150MHz receivers." The chart, referred to on page 22 of the article, is used in keeping the second conversion oscillator's multiple harmonics out of the bandpass of tuned circuits:

OSCILLATOR FREQUENCIES		
CARRIER FREQUENCY (f _c)	1ST OSCILLATOR FREQUENCY RANGE (MHz)	2ND OSC. FREQ. (MHz)
139.5400-139.5800	60.8200-60.8400	18.355
139.7670-139.8830	60.9335-60.9915	18.355
140.1460-140.2630	61.1230-61.1815	18.355
140.4500-140.4900	61.2750-61.2950	18.355
142.3750-142.3980	62.2285-62.2480	18.355
142.6170-142.6570	62.3585-62.3785	18.355
143.3020-143.3420	62.7010-62.7210	18.355
143.6660-143.7060	62.8830-62.9030	18.355
145.5060-145.6990	63.8030-63.8995	18.355
145.9610-146.0020	64.0305-64.0510	18.355
146.1130-146.1460	64.1065-64.1230	18.355
148.4850-148.5350	65.2925-65.3175	18.355
148.8788-149.6000	43.6596-43.9000	18.355
151.4370-151.8105	44.5243-44.6368	18.355
152.2607-152.3007	44.7869-44.8002	18.355
152.6620-152.6910	44.9207-44.9303	18.355
153.6780-153.7180	45.2593-45.2727	18.355
154.2240-154.2640	45.4413-45.4547	18.355
155.0888-155.1288	45.7296-45.7429	18.355
155.4380-155.4700	45.8460-45.8567	18.355
156.9850-157.9350	46.3617-46.6783	18.355
160.1271-160.1671	47.4090-47.4224	18.355
161.4600-162.1825	47.8553-48.0942	18.355
163.1033-164.1850	48.4011-48.7617	18.355
164.6910-164.7310	48.9303-48.9437	18.355
165.9350-165.9750	49.3450-49.3583	18.355
166.3900-166.4300	49.4967-49.5100	18.355
167.2140-167.2540	49.7713-49.7847	18.355
167.6040-167.6440	49.9013-49.9147	18.355
168.1725-168.2125	50.0908-50.0142	18.355
168.5138-168.5538	50.2046-50.2179	18.355
173.5200-173.5600	51.8733-51.8867	18.355

(Frequencies not listed use 17.445MHz for the second oscillator.)

Carrier frequency:

$f_c = 2f_o + 17.900\text{MHz}$ (138.000 - 148.599 MHz)

$f_c = 3f_o + 17.900\text{MHz}$ (148.600 - 174.000 MHz)

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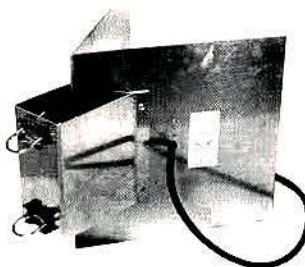
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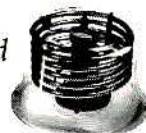
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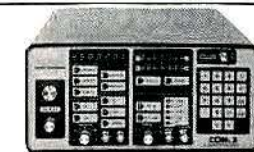
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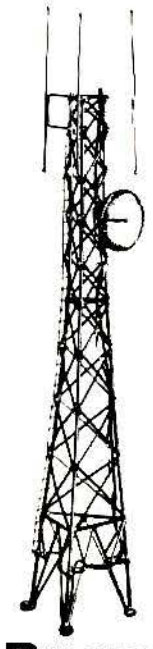
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MOT RACAL-VADIC, As above, master rack unit	\$150.00
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MOT "Micor" 30" cabinet only	\$50.00
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MOT "Micor" "Spectra-Tac" UHF, SAT, r'cvt, C/S/Q	\$350.00
MOT "M100" 150-174MHz, 25w, 2f, 3/yr warr.	New, \$285.00
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MOT "Director II", As above, w/o charger	\$60.00
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P-D RMC150-16B, 150MHz, 12/16 r'cvt, M-coupler	\$125.00
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RJ RMC-460-116R, 450MHz, 12/16 r'cvt, M-coupler	\$150.00
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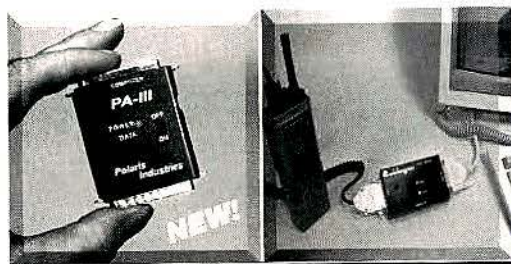
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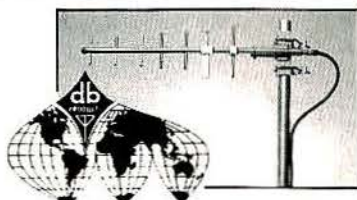
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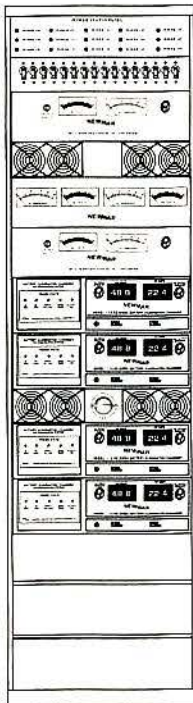
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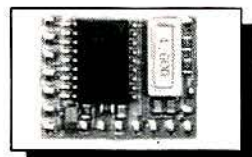
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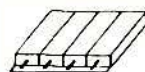
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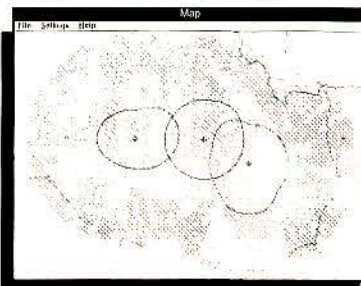
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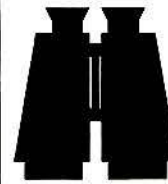
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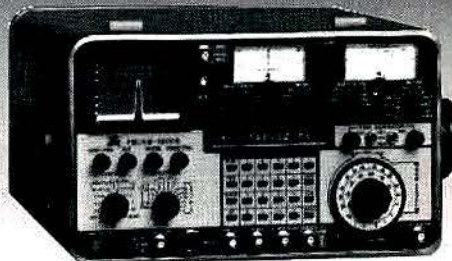
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Allen Telecom Group	37	33	804-385-7651	Megahertz Technology, Inc.	94	113	214-341-0562
Andrew Corp.	IBC	2	708-349-3300	Meridian Communications	33	29	818-222-5655
The Antenna Farm	103	137	800-255-6222	Metroplex Mobile Data	54	48	305-739-0850
Astron Corp.	47	43	714-458-7277	Microwave Filter Company, Inc.	16	13	315-437-3953
Automation & Electronics Engr.	103	138	800-527-4596	Midian Electronics, Inc.	41	36	602-884-7981
AutoTrac, Inc.	30	26	214-480-8145	Midland International LMR	34,35	30,31	800-MID-LAND
Avcom of Virginia	76	74	804-794-2500	Mobile Mark, Inc.	52	46	800-648-2800
Barnett Electronics, Inc.	101	133	800-423-3858	Modular Communication Systems	87	91	818-764-1333
BEE Electronics, Inc.	75	73	800-336-3115	Motorola C&E	110	155	708-538-6333
Bramco, Inc.	98	126	513-773-6255	Motorola Test Equipment	15	12	800-235-9590
CELWAVE	13	10	800-321-4700	MX-COM, Inc.	7	7	800-638-5577
Centurion International, Inc.	9	8	800-228-4563	NATCOM, Inc.	64,98	59,125	800-844-8287
Chargeguard Corp.	104	141	800-458-3410	NEC America, Inc.	49	44	214-751-7273
Christie Electric Corp.	76	75	310-715-1402	New Mar	104	142	800-854-3906
Cimarron Technologies	25	21	800-487-7184	Norton Engineering	106	149	703-938-5745
David Clark Co., Inc.	38	34	508-751-5800	Omnicon Electronics	81	84	203-928-0377
Combined Technologies, Inc.	81	83	513-595-5900	Orbacom Systems, Inc.	53	47	609-829-4455
Comm-Tech International	75	72	407-291-9009	PageTek, Inc.	86	98	919-876-8294
Communications Associates	98	123	800-435-9313	PanaVise Products, Inc.	36	32	702-353-2900
Communications Data Services	105	145	800-441-0034	Pekaar Communication, Inc.	99	130	201-132-0704
Communications Instruments	108		303-962-9998	PerCon Corporation	109	150	716-386-6015
Communications Mktg. Assoc.	71	67	303-371-8182	Photocomm, Inc.	89	94	800-223-9580
Communications Specialists	BC	3	800-854-0547	Polaris Industries	102	135	800-752-3571
Computer Resources, Inc.	107	144	205-987-1523	Polyphaser Corp.	32	28	800-325-7170
Connect Systems, Inc.	54	49	800-545-1349	Pyramid Communications	106		310-430-5892
Consumer Microcircuits Ltd.	85	87		Quantum Publishing, Inc.	78	78	415-381-4488
Control Signal Corp.	26	22	303-989-8000	Radio Express, Inc.	95	114	703-266-1928
CPI Communications, Inc.	16	14	214-437-5320	Radiomate	72	68	800-346-6442
Cushcraft/Signals Corp.	27	24	800-258-3860	Radio Wholesale	99	129	800-53R-ADIO
Daniels Electronics	58	53	604-382-8268	RAM Communications Consult.	92	110	908-636-6970
Diablo Communications, Inc.	109	154	510-236-3700	Ramsey Electronics	96	118	716-924-4560
D & L Communications, Inc.	68,96	63,119	800-336-6825	RCW Distributing	97	121	800-726-9015
D & L Communications, Inc.	103,108	139,152	800-336-6825	Rocky Mountain Comms, Inc.	107		303-526-5454
Doppler Systems, Inc.	88	92	602-488-9755	Schlumberger Technologies	21	18	800-225-5765
Douglas Integrated Software	106	148	904-656-8673	Sentry USA	107	146	407-773-6090
Duracom	98	124	913-746-8300	Serviceware Corporation	44	40	613-521-7391
DX Radio Systems	67	62	213-257-0800	Sharp Communication	98	127	800-548-2484
Eagle Wichita	80	80	316-265-2050	Shure Brothers, Inc.	45	64	800-25S-HURE
Eastern Radio Service	95	115	704-847-0612	Softwright	107	143	303-344-5486
E F Johnson	50-51	45	800-328-3911	Solar Electric Specialties	44	39	800-344-2003
Electrocom	62	57	310-946-9493	Sonic Communications, Inc.	12	9	800-688-1944
EMR Corp.	80	82	602-581-2875	Spacecom Systems, Inc.	5	6	800-950-6690
Ericsson GE Mobile Comms	39	35	800-GE1-2345	Spectrum Communications Corp.	62	56	610-631-1710
E Trunk Systems, Inc.	104	111	914-245-1128	Stancil Corporation	57	52	714-546-2002
Everon America, Inc.	61	55	800-603-3766	Tait Electronics USA, Inc.	24	20	713-984-8684
Fourth Dimension	101	134	516-467-1220	Telepoint, Inc.	77	76	310-652-3666
Frequency Management	99	128	800-800-9825	Telewave, Inc.	74	70	415-968-4400
Gamber Johnson	60	97	715-344-3482	TGA Systems, Inc.	46	42	404-441-2100
Haewa Corporation	85	88	800-783-4239	Times Microwave Systems	79	79	203-949-8400
Helper Instruments Co.	66	61	407-777-1440	Towerwatch	111	156	913-233-2343
Henry Radio	56,97	51,120	800-877-7979	Transcript International, Ltd.	3	5	800-228-0226
Hewlett Packard	43	38	509-921-4001	Trident Micro Systems	86	89	800-798-7881
Hustler, Inc.	17	15	800-949-9490	Trylon Manufacturing Co., Ltd.	89	95	519-669-5421
Hutton Communications	20	17	800-442-3811	TX RX Systems, Inc.	29	25	716-549-4700
Hy-Q International	99	131	606-283-5000	Uniden Corp of AM-MSG, Inc.	19	16	817-858-3300
ICT Systems, Inc.	80	81	800-779-1917	Vega, A Mark IV Company	1	4	818-442-0782
IFR Systems, Inc.	59	54	316-522-4981	Versatel Communications	97	122	800-456-5548
Interactive Systems, Inc.	88	93	703-812-8270	Vocom/RF Corporation	74	71	800-USA-MADE
ITC Instruments	69	65	800-566-1818	Wacom Products, Inc.	26	23	817-848-4435
Kenwood U.S.A. Corporation	23	19	310-639-4200	West Coast Radio	102	136	310-268-2464
KNS Electronics, Inc.	84	86	408-432-8100	Western Multiplex Corp.	83	90	415-592-8832
Larsen Electronics	31	27	800-426-1656	Wetec Electronics	103	140	901-286-6275
Lazer Beepers, Inc.	108	151	800-354-3405	WirelessWorld Conference	82	100	913-967-1848
Leavitt Communications, Inc.	90	96	708-982-0220	W & W Associates	65	60	800-221-0732
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